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Modern Telephone Exchange Systems.

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I.

The development of the telephone exchange switchboard has kept apace with the growth of the telephone industry, solely in that its appliances have been able to successfully handle the business thrown upon them, but the word successfully is used in a restricted sense, as it cannot be said that heretofore large exchanges have been handled satisfactorily. In fact, the dissatisfaction expressed has been universal and emphatic, but no recourse being at hand, telephone companies have been forced to invest mountains of money in switching apparatus that was realized to be deficient in many respects. In brief, the growth of the telephone industry has placed it far in advance of the art of switchboard building, particularly in that heretofore inventors have apparently been unable to devise switchboards that could be constructed without entailing infinite complexity in wiring and almost extortionate cost.

It may be said with propriety that there has been too little originality exercised in the invention of methods of handling telephone exchanges, and that telephone engineers, having been wedded early in their experiences to the forms of switchboards now almost universally used, have unfortunately fallen into the belief that there are no "good fish in the sea." A consideration of modern telephone exchanges must, perforce, exclude reference to the earlier devices of the art, but the single observation may be made that the principal systems now universally used contain points of resemblance, if not identity, that lead to the conclusion that the efforts of the successful inventors have hitherto been confined to well trodden paths of research, and certain it is that no system presenting features showing radical or fundamental departures from the generally accepted principle of switchboard construction, has heretofore achieved prominence. The "Multiple" system has long been pre-eminent among telephone switchboards and an acknowledged authority * observed as late as July, 1893, that "it is difficult to conceive of a telephone exchange of, say, 6,000 subscribers being worked at all upon the ordinary principle, while it is a comparatively simple matter with Multiple boards;" indeed, the Multiple switchboard is described as "the nearest approach to a perfect system that has yet been devised," and it is stated that "it is now adopted almost universally for large exchanges."

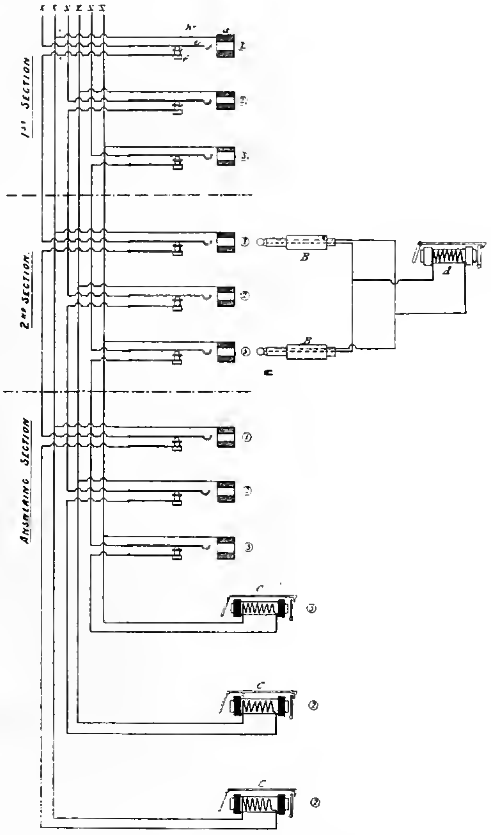

FIG. 1. THE "MULTIPLE" SYSTEM.—SIMPLIFIED DIAGRAM OF THE SERIES-MULTIPLE SWITCHBOARD.

REFERENCES.—*A*, *Ring-off Drop.*—*B*, *Plugs.*—*C*, *Subscribers' Drops.*—*X X X*, *Subscribers' Lines.*—*a*, *Test Thimble.*—*e*, *Tip Spring.*—*f*, *Annunciator Contact.*—*h*, *Line Closing Contact.* *1, 2, 3, Subscribers' Spring-jacks.*

A number of the leading telephone engineers of America, however, who have examined a system invented and now in use by the Pacific Telephone and Telegraph Co., and which is known as the "Limited Express" system, have expressed the opinion that the "Express" system is entitled to the distinction of being the peer of the Multiple switchboard in every point as to reliability, flexibility, rapidity of switching and cost of installation and maintenance. As yet no one has been able to indicate a real disadvantage in its use, and the only criticism that has been offered, is that it does not present the feature peculiar to the Multiple board that the entire act of switching may be accomplished by a single operator.

The topic of Modern Telephone Exchange Systems, therefore, only embraces the consideration of Multiple and Express switchboards, but as the Multiple system has received extended description in other publications and as its fundamental principles of operation are well understood, it is believed that a detailed description of its plan of operation is unnecessary.

II.

It is well understood that the essential idea of the Multiple board is to enable the act of switching to be performed by a single operator, and in order to explain how this is accomplished, it is well to consider subscribers' lines as being "incoming" or "outgoing," according to whether the subscriber is a (1) "calling" or (2) an "answering" or a "called" subscriber. Each operator is capable of handling the calls of say 200 subscribers, but these "calling" subscribers will desire connection

* Preece & Stubbs' "Manual of Telephony," Page 247.

with the lines of all subscribers in the exchange; consequently, each operator's section must contain not only the spring jacks and annunciator drops for the 200 subscribers whose calls she answers, but also the spring jacks forming the terminals of the lines of every other subscriber in the exchange. Upon this basis therefore, an exchange of 3,000 subscribers will be divided into 15 operators' sections, and as each operator answers the calls for 200 subscribers, there will be 200 subscribers' drops to each section, or 3,000 drops in all. But each operator must have represented on her section a spring jack forming the terminal of the line of each subscriber in the exchange, or 3,000 to each operator's section.

The necessity of some means by which any operator may determine whether the line of a called or outgoing subscriber is busy is readily perceived, and Multiple boards of whatever variety are provided with a test circuit for each subscriber which is brought out in the form of a tube or thimble at the entrance of each spring jack. Before inserting the plug into the jack forming the terminal of the outgoing subscriber's line, the operator touches the tip of the plug to this test thimble, and if the line of the called subscriber is engaged the operator is informed accordingly from the occurrence of a sharp click in her telephone receiver. This test thimble is shown as *a* on the accompanying diagrams of Multiple switchboards, Figs. 1 and 2.

Having these facts in mind the consideration of the different forms of Multiple boards may be intelligently undertaken.

III.

The old form of Multiple switchboard, known as the series-multiple board, is shown diagramatically, and in its greatest simplicity, in Fig. 1. It is distinctively a magneto system, as both the subscribers drops C, and the ringing-off drop A are actuated by magneto currents generated at the subscriber's station. Its characteristic feature rests in the fact that the spring-jack appearing on each section for a given subscriber is wired in series with the spring-jacks for the same subscriber appearing on every other section, hence the insertion of a plug in a given subscriber's spring-jack on any section cuts the circuits terminating in the plug, into circuit with the subscriber's line. Obviously, then, each spring-jack is liable to cause an open circuit in a subscriber's line by reason of opening at the line-closing contact *h*, which may occur from corrosion or the lodgment of dust at that point or from the weakening of the tip spring *e*, or the line-closing contact *f*. The ringing-off annunciator drop A remains across the subscribers' lines in multiple during the conversation. The series-multiple system presents no automatic self-restoring features, hence requires manual effort on the part of the operator, not only in restoring the drops, but in ascertaining whether the subscribers have performed the ringing off and other duties expected of them.

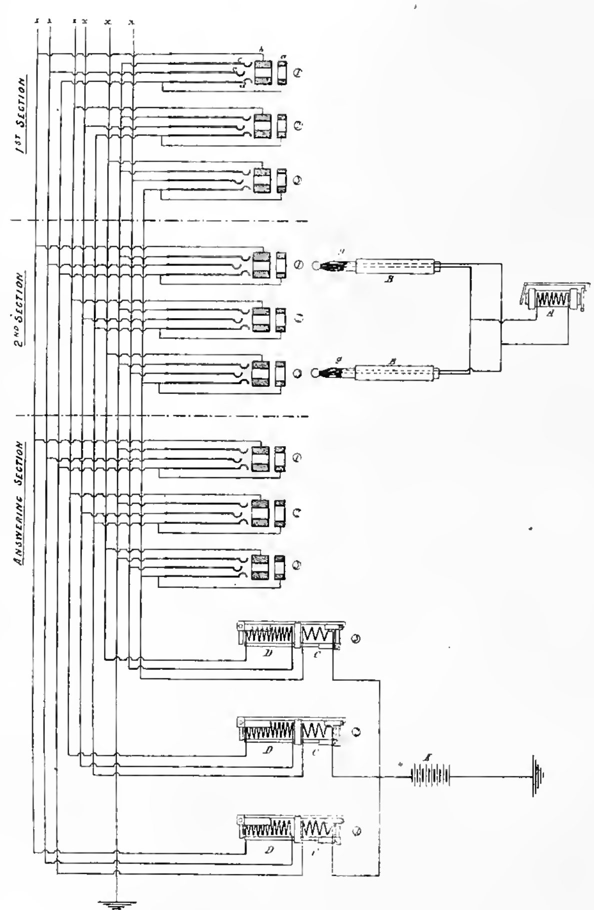

Fig. 2. The "Multiple" System.—Simplified Diagram of the Bridging-Multiple Switchboard.

References.—*A, Ring-off Drop.—B, Plugs.—C, Self-restoring Magnets.—D, Subscribers' Drops.—E, Self-restoring Magnet Battery.—X X X, Subscribers' Lines.—a, Test Thimbles.—b, Sleeve Ring.—c, d, Self-restoring Magnet Contacts.—e, Tip Spring.—g, Insulated Metallic Ring.—1, 2, 3, Subscribers' Spring-jacks.*

These and other defects of serious importance led to the designing of the Bridging-Multiple switchboard, the simplified circuits of which are shown in Fig. 2, in their most perfected forms. As its name implies, the characteristic of the bridging system lies in the arrangement of the subscribers' jacks, the spring-jack for a given subscriber being "bridged" or wired in multiple with the spring-jacks for the same subscriber appearing on every other section, thereby obviating the troubles common to the Series board from the opening of circuits at the line-closing contacts in the spring-jacks; but in obviating one trouble a second, though less serious one, is encountered, namely, the liability of short-circuiting from the enormous amount of parallel wiring.

The most approved forms of bridging-multiple boards contain automatic or self-restoring subscribers' drops, actuated by a battery, shown as E, in Fig. 2. The plug B contains a metallic ring *g* placed near the tip and insulated therefrom. When inserted in the spring-jack this ring *g* short circuits the springs *c d*, which closes the circuit of the battery E through the restoring winding C of the subscribers' drops D, thus relieving the operator from restoring the drop after having answered the call. The act of inserting the plug B in the spring-jack cuts into the subscriber's line in multiple through the contacts of the sleeve and tip of the plug with the sleeve ring *b* and the tip spring *e* respectively. The ringing-off or clearing annunciation must be rendered by the subscriber actuating the ringing-off drop A, as in the series-multiple system.

In order that a more clear understanding of the details of operation of multiple boards may be had, it is well to refer again to Fig. 1, which, as stated, illustrates diagramatically the most approved form of the series-multiple switching system as used preferably on metallic circuits. In this the three subscribers' lines XXX, etc., are shown entering three sections of the board, the last of which is the "answering," or "local" section—that is the section answering the calls of the three subscribers located thereon. The plan of circuit wiring, shown in the first and second sections, describes the manner in which all remaining sections of the exchange are wired, and of course, each of these other sections forms the answering section for a particular group of subscribers entering the exchange, as previously described.

It will be noted by reference to Fig. 1 that one side of the subscriber's line, when it reaches the switchboard,

is cut into *in series* by as many spring-jacks as there are sections to the board, while the other side of the subscriber's line continues on uninterruptedly paralleling the first side of the line until together they reach the subscriber's annunciator drop, shown as C, but at each point where a spring-jack is cut into the first side of the line, a tap or branch wire is taken from the second side of the line and continues on to the test thimble *a*. If, now, the function of the spring-jack be considered as opening the subscriber's line at the contact *h*, by lifting the tip spring *e* from the annunciator contact *f*, then the spring-jack becomes a simple series device for opening the line. If the function of the spring-jack be considered as a means for enabling a plug circuit to be bridged or cut in, *in multiple* with the subscriber's line through the contact of the tip spring *e* and the test thimble *a*, with the tip and sleeve respectively of the plug B, then the spring-jack becomes a simple multiple device for bridging on to the circuit at any section. In point of fact the spring-jack performs both these functions, hence the insertion of a plug in the first section opens the subscriber's line on all points beyond that section, which explains why the signaling back of a called subscriber does not throw the drop of that subscriber on its own particular answering section.

The second side of the subscriber's line referred to constitutes the "test wire," the use of which will be understood when it is stated that the wiring of each pair of plugs is grounded through a small battery and retarding coil and that each operator's receiver is also grounded, so that if the spring-jack for a given subscriber is in use on any particular section a grounded battery current will be thrown upon the test thimble of each spring-jack for the same subscriber in every other section, hence the touching of the tip of the plug to the test thimble will complete the grounded battery circuit, giving the sharp click in the operator's instrument, previously referred to.

Beyond this apparatus the operators' tables are equipped with listening keys and ringing keys, together with the ringing-off drop A.

Fig. 2, showing a simplified diagram of the bridging-multiple switchboard, represents the most approved form of Multiple switching. The spring-jacks differ from those in use on the series board in that they have five terminals, two of which, the test thimble *a* and the self-restoring magnet spring *d*, are common points and, forming the test wire, are continued to each section. The self-restoring magnet wire ending in the spring *c*, and which is grounded, is common to every spring-jack in every section. The spring-jack, therefore, has three separate and distinct uses. First, to enable the cutting of a plug circuit into circuit in multiple with the subscribers' lines XX. Second, to enable the operator to apply the "busy" test by touching the plug switch to the test thimble *a*, and third, to restore the subscriber's indicator by short-circuiting the springs *c d* through the plug ring *g*. The subscribers' indicators contain two windings, as shown at D and C, which are respectively used for throwing the annunciator drop, by means of the subscriber's magneto current, and for restoring this drop by means of current sent through the coil C from the battery E, when the spring-jack points *c d* are short circuited. The test wire circuits are operated in a manner identical to that used in the series-multiple system, which the bridging-multiple system further resembles in the arrangement of the ringing-off drop A.

Experience has proven that the bridging-multiple system is far more reliable than the series-multiple board, particularly for its greater immunity from trouble and because of the self-restoring features of its indicators. Like the series system, however, it requires a manual test for "busy" and for checking subscribers who do not ring off. It also has the disadvantage of maintaining devices, such as the ringing-off drop A and the subscriber's drop D, permanently across the circuit which, together with the use of grounded circuits for special work, is oftimes seriously objectionable. While the bridging-multiple board is less liable to trouble than the series-multiple board, it is at the same time harder to find such troubles as do occur. A recent writer,* commenting on this fact, points out that with the older styles of switchboard, in which the insertion of a plug cuts out the drop, it is an easy matter to test all wires from one of the sections of the board itself; but, with the bridging type of board, the case is more difficult as the drop is never cut out, and a line will show closed through the drop irrespective of its condition outside the office.

In order that an idea may be conveyed as to the difficulty attending the localizations of switchboard "faults," it may be well to describe a method due to Mr. Manson, in which subscribers' lines are handled by bridging multiple boards and consequently with normally open spring-jacks and high resistance subscribers' indicators.

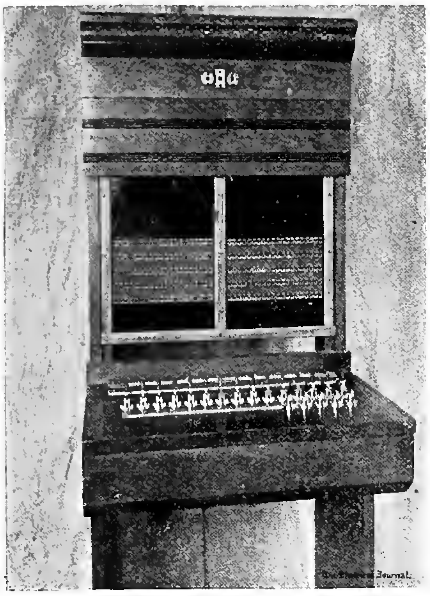

FIG. 3.—THE EXPRESS SYSTEM.—A COMPLETE SECTION OF THE "A" SWITCHBOARD.

The peculiarity of the method is in the arrangement of the testing outfit, which is a modification of the Wheatstone bridge. Its essential features are a differentially wound relay; that is, a relay having two windings, A and B, each of equal resistance and connected in series; a third wire terminating in the hammer of a telegraph key being run from the middle connecting point. A second feature of the testing set consists in the use of a resistance equal to that of a regular subscriber's indicator drop. The set also contains a suitable battery and an ordinary plug with flexible cord to connect into any spring-jack desired.

The arrangement of these devices is such that the key and battery are bridged across from the middle point of the differential relay, shunting the differential

* James W. Manson, Electrical Engineer (N. Y.). Nov. 28, 1894.

relay coil B and the resistance in series on one side, and the differential relay coil A and the plug in series on the other, thus balancing a known resistance against whatever resistance there may be on the circuit of the spring-jack into which the plug is placed.

To make the test the plug is inserted in a spring-jack, and the key closed. In case the line is open at any point outside the office, the current from the battery divides equally between the two coils, A and B, of the differential relay, with consequently no effect on its armature. If, on the contrary, the line is intact, coil A gets more current than coil B, as the joint resistance of subscriber's line and drop in parallel is less than that of R. When a line is closed then the relay armature is attracted with an intensity proportional to the difference between the currents flowing through the coils A and B.

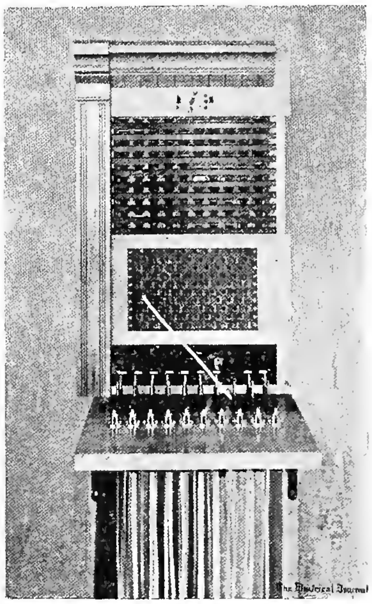

Fig. 4.—The "Express" System.—A Complete Section of the "B" Switchboard.

Regardless of the many deficiencies of Multiple switchboards, whether of the series or bridging-multiple forms, they have constituted the most serviceable appliance available, but their chief drawback, and which alone would have long since condemned them had there been a qualified substitute available, lies in the great complexity and detail of the wiring essential to their construction. When it is remembered that in the case of 3,000 subscribers, as cited, there must be 45,000 spring-jacks in an exchange using the Multiple board, and when, as is seen by reference to Fig. 2, each spring-jack necessitates the use of five wires to connect its working parts to the main wires running through from section to section, the appalling complexity of the wiring of a Multiple board in a large exchange will be appreciated, as will also the fact that the expense of installation and the cost of maintaining it free from troubles are important items.

IV.

The "Express" system, which is the joint invention of Messrs. John I. Sabin and William Hampton, is so radically different in principle from "Multiple" systems that at first impression it appears to be seriously complicated, but when its working principles are understood the idea of complexity vanishes. Aside from its thorough practicability, moreover, it presents many novel, interesting, invaluable and distinctive features. The system has been in use in San Francisco for nearly two years, and while the perfected methods of operation, as hereafter described, have not been carried out with each subscriber, yet each feature presented has been fully and extensively tested under actual working conditions and its reliability has been demonstrated. Rapid progress is now being made in changing the equipment of the Pacific Telephone and Telegraph Company so that it will conform fully to the perfected "Express" system, as herein described. Two years ago the "Multiple" system was abandoned and experiments were undertaken in line with the ideas herein set forth, and as a result of the evolution of the perfected "Express" service San Francisco to-day contains a mixed telephone system in which the use of the perfected "Express" predominates, but in some cases metallic "Express" is connected to grounded "Express," or to metallic or grounded magneto service, or grounded "Express" is connected to grounded magneto lines, and grounded magneto lines are connected to grounded magneto lines through grounded or metallic "Express" system, all with far greater satisfaction from every point of view than is possible in the use of "Multiple" boards.

A distinguishing feature of the Sabin-Hampton "Express" system rests in the fact that the switchboard is split into two sections, each independent and different in design from the other and each performing a separate or individual function. These two sections are arbitrarily designated as "A" boards and "B" boards respectively, and the same mode of designation follows through all features of the "Express" system. There are, for instance "A" operators and "B" operators, and "A" trunks and "B" trunks, etc., which at once defines the purpose of the operator or the trunk. Subscribers become "A" and "B" subscribers according to whether they are the calling or "incoming," or the called or "outgoing" subscriber. It is upon the distinction between these terms that the basis of the "Express" system rests, and a full comprehension of their significance must be attained in order to enable the system to be described understandingly.

It may be said with accuracy, though in a general

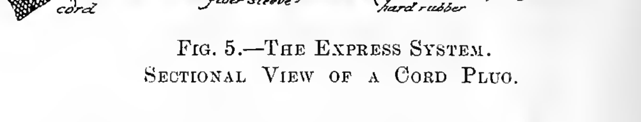

Fig. 5.—The Express System. Sectional View of a Cord Plug.

way, that the calling, or incoming subscriber, is handled by "A" equipment, while the called or outgoing subscriber, is handled by "B" equipment. One hundred numbers constitute a section on either board, and each section of the "B" board contains the permanent spring jack terminals and subscriber's indicators of the lines of the subscribers on that section, together with the cords and plugs for a limited number of local trunks and their clearing-out indicators and ringing-up magneto keys, as shown in figure 4. Each section of the "A" board (illustrated in Figure 3) contains spring jacks forming the terminals for the set of local trunks going to the "B" board and known as "B" trunks, and also cords and plugs leading from the "B" board and known as "A"

plugs. This simple arrangement, together with the visual indicators and various keys for switching the operator's instruments into circuit with calling subscribers or "B" operators, forms practically the entire equipment of the "A" board.

The "B" board is therefore the subscribers' lines' board, and it is, in brief, a counterpart of the ordinary multiple switchboard, with the exceptions that in the "Express" system each section contains only the subscribers' annunciators and spring jacks for one hundred subscribers, together with not exceeding twenty trunk plugs, while in the multiple system each section contains not only the subscribers' annunciators and spring jacks for that particular section, but also spring jacks for every subscriber received on every other section, often reaching thousands of connections, as fully explained heretofore. Clearly, then, the "B" operator in charge of a given section has in her care mainly the subscribers' annunciators and jacks of that particular section, and is dependent upon using trunk lines for making connection with other sections. She perceives when a subscriber on her section is making a call, and with a single, simple motion, sends the call over to the "A" board for another operator to take care of, but when a subscriber on her section is called she rings him up and sees that he responds. Almost the entire work of the "B" operator, therefore, consists in switching for the outgoing subscribers on her section, and she is therefore considered as the operator in charge of a section of outgoing or called subscribers—in brief, a "B" operator.

An understanding of these divided boards and of the trunk lines may be attained by defining "A" operators and switchboards as affording facilities for the manipulation of such temporary extensions of subscribers' circuits as the "B" operators may make by plugging subscribers' lines over to the "A" board through the extension or trunk lines. The "A" board must therefore, be considered as the means by which a temporary "jumper," or "bridge," may be run connecting the calling subscriber's spring jack in one section of a "B" board with the spring jack of the called subscriber located in another section of the "B" board. If, now, a primitive exposition of the principles of operation of the "Express" system is desired, it can be given in no more simple way than to state that the proper operators on the "B" board extend the lines of the calling and called subscribers over to the "A" board where an "A" operator brings the lines together, thereby closing the circuit and establishing communication.

V.

In practice,however, the execution of the apparently simple act of connecting two subscribers lines together, becomes quite complicated when it has to be accomplished to the full satisfaction of the exacting demands of metropolitan telephone service. To do this, the additional equipment necessary in the making of switch connections within a single exchange operated on complete metallic service, consists of a number of accessory devices about to be described.

Cords and plugs are the devices used for making switchboard connections on account of their flexibility and ease of manipulation. They are double pole throughout; that is, each cord contains two separate conductors terminating in the sleeve and tip of the plug, respectively. The plug used in the "Express" system contains a distinctive feature in the placing of a stiff steel spring axially along the surface of the sleeve, thereby insuring a firm and reliable mechanical contact between the sleeve and the tube of the spring-jack as shown in the sectional actual size view of the plug exhibited in Fig. 5.

The spring-jack used in the "Express" system is a very neat and compact device, mounted on hard rubber, and shown as B in the accompanying illustration (Fig. 6), of a decade of subscribers' spring-jacks taken from the jack section of a "B" board. Its working parts are best described by reference to Figure 7, which illustrates the "B" board diagramatically, and from which it will be seen that the jack consists of two springs *a*, *b*, normally in firm contact with the points *c*, *d*. These springs *a*, *b*, form the terminals of the subscriber's line, and the fact that each subscriber has but a single spring-jack and consequently but a single line terminal in the whole exchange, should be emphasized, as it is a distinguishing feature in the "Express" system. The points *c*, *d*, form the terminals of the subscriber's battery, and as the jack-springs *a*, *b*, are normally in contact with the points *c*, *d*, it is clear that when the line is not in use the potential of the subscriber's battery is upon it.

The description of the subscriber's telephone equipment, which is given elsewhere, points out the fact that when the receiver is on the hook, the subscriber's line is open so far as the subscriber's battery is concerned, with the battery upon it, and also that the act of raising the receiver from the hook, closes the line and battery through the receiver and the secondary of the induction coil. It is in the subscriber's spring-jack that the battery connection with the subscriber's line is made by reason of the pressure of the springs *a*, *b*, against the points *c*, *d*, but before the battery reaches the points *c*, *d*, in each subscriber's spring-jack, it passes through the individual annunciator drop or subscriber's indicator for that particular jack. Clearly, then, the raising of the subscriber's receiver from the hook closes the line circuit through the telephone, the secondary of the induction coil and the annunciator drop on the "B" board, and clearly, also, will the insertion of a plug into the spring-jack of the subscriber indicated upon the subscriber's drop, restore the gravity annunciator drop through the breaking of the contacts between the springs *a*, *b*, and the points *c*, *d*, respectively, and at the same time remove all connection between the subscriber's calling battery and the subscriber's line.

Trunk lines are used only for conversational purposes by subscribers, and are not called upon for office duty between operators or otherwise. Their specific utilization consists in the making of temporary extensions of subscribers' lines between "B" boards and "A" boards. The trunk lines are divided into two classes, known as main trunks, or those extending between branch and main offices and local trunks, or those extending between the "A" and "B" boards of a single office. Main and local trunks are each in turn divided into two classes, namely, "A" and "B" trunks. "A" trunks are those running from incoming "B" boards to "A" boards, and have each end terminating in a plug, while "B" trunks are those appearing on the "A" boards as spring-jacks and run to outgoing "B" boards direct, where they terminate in the form of plugs. It is through the use of local trunks, therefore, that the lines of conversing subscribers are extended from their permanent sections on the "B" board to a given section of the "A" board. "B" trunks invariably extend as outgoing from an "A" section spring-jack to a "B" section plug without being interrupted by any switching or other device, as will be shown, but "A" trunks are each cut into by the intermediate cross connecting board, or the distributing board on the way from the calling subscriber's, or the incoming "B" board to the "A" board.

Upon tracing the route of exchange switching it will be found that the incoming "B" operator, or the one having charge of the section upon which a call originates, will plug a local "A" trunk into the calling

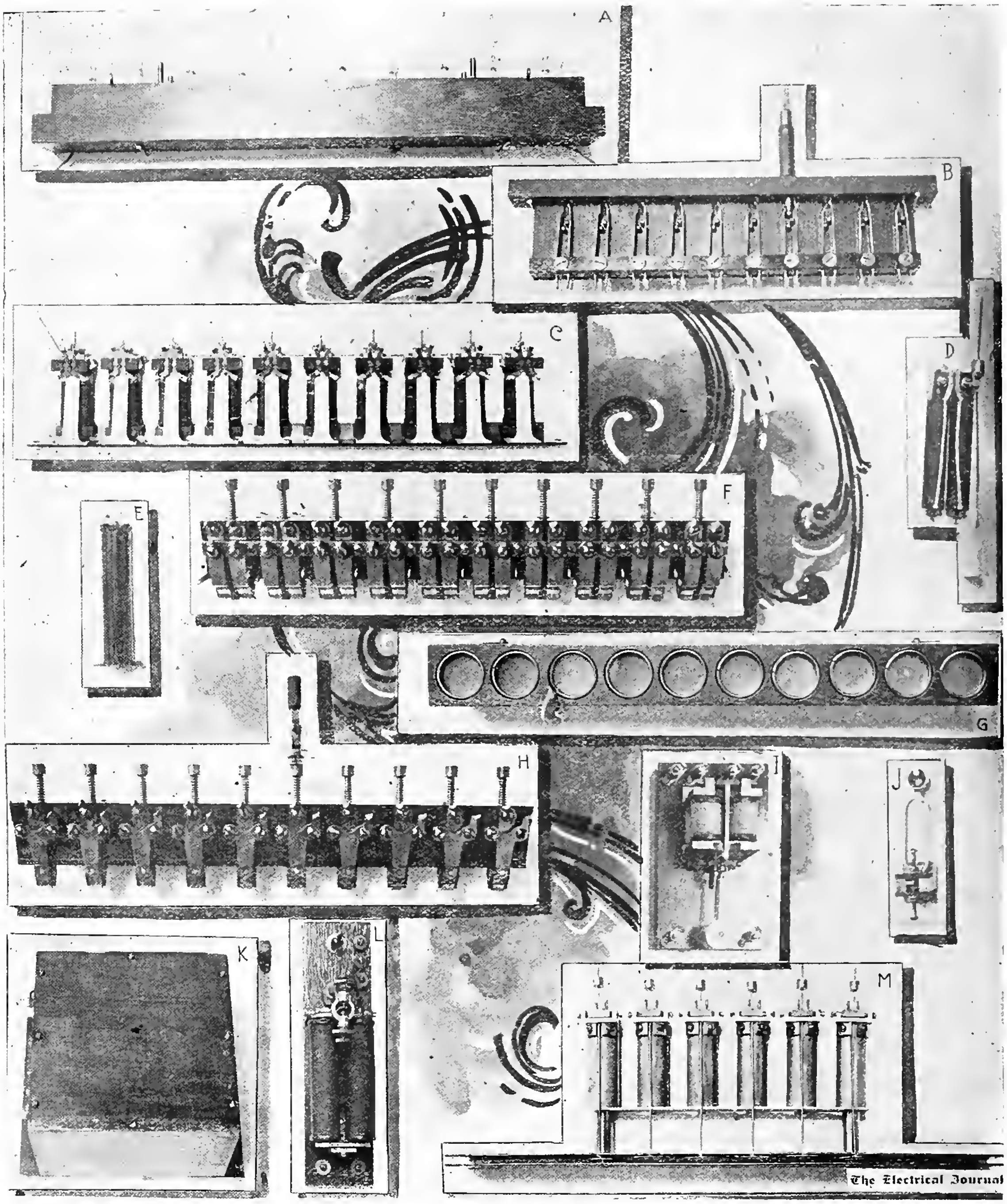

FIG. 6.—THE "EXPRESS" SYSTEM.—SOME DEVICES USED.

REFERENCES.—*A, Trunk Indicator Lamp Rack.—B, Decade of Subscribers' Spring-jacks showing Battery Contact Points and mode of Inserting Plugs.—C, Decade of Subscribers' Self-restoring Drops, with aluminum Shutter.—D. Trunk Clearing Indicator Relay.—E, Balancing or Retarding Coil.—F, Decade of Ringing Keys, the Reverse Side of which is per H. G, Cover for Lamp Rack A.—H, Decade of Listening Keys.—I, Compound Relay.—J, Plug Gravity Lamp Indicator Switch.—K, Condenser.—L, 1.000-ohm Relay. M, Magnetic Trunk Clearing Indicator.*

subscriber's spring-jack. This "A" trunk does not take the call through the "A" board direct but constitutes the first division of the entire "A" trunk or the division which extends from the "B" board to the intermediate board. From the intermediate board, the second division of the "A" trunk is continued to such particular section of the "A" board as may have been predetermined by the chief operator, who regulates the number of "B" sections each "A" operator is to handle as incoming according to the methods shown in the detailed description of the intermediate board. It is from the intermediate board therefore that the call continues along the second division of the "A" trunk until it reaches its proper "A" plug on the "A" board. The "A" operator then plugs this "A" trunk into the spring-jack forming the terminal of the proper "B" trunk, which carries the circuit to the section of the "B" board containing the called or outgoing subscriber's spring-jack where the only remaining opening in the circuit is closed by the outgoing "B" operator, all as fully described hereafter. Trunk lines have condensers in circuit and also the indicator batteries and devices, affording means for manipulating indicator signals as will be shown.

VI.

It is well known among those who are familiar with telephone exchanges that during certain hours of the day there will be comparatively little business to handle, while at other hours each and every operator will be kept exceedingly busy and the exchange will be running to its full capacity. It is this situation that led to the designing and use in San Francisco of a special distributing switchboard called the intermediate cross-connecting board, which affords the means by which the business received by the "A" board from the incoming "B" board may be split up and evenly apportioned among the operators handling the various sections of the "A" board. There are furthermore certain hours, particularly at night, when a single "A" operator can handle all the "A" board switching, in which event every section of the "B" board may be thrown upon say two sections of the "A" board by properly switching the local "A" trunks thereto at the intermediate board. Then, at other times of day, the rush of business will be so great that it will be necessary for each "A" section to be worked to its fullest capacity, in which event the "A" trunks will be so commutated at the intermediate board that each section of the "A" board will be called upon to handle the incoming switching business of say two or three sections of the "B" board. There is, therefore, no fixed or permanent connection between given "A" sections and given "B" sections of the switchboard, nor does a given "A" trunk starting at a given "B" section have a fixed or permanent terminal at any given section of the "A" board, but the "A" trunks connecting the "A" and "B" boards are changed during the day according to the volume of business transacted. This is done through the intermediate board, which cuts into the "A" trunks only and is so designed that its upper portion contains rows of spring-jacks forming the terminals of the division of the "A" trunk, which ends at the "A" board. Inasmuch as each section of the "A" board receives the incoming business of fifteen "A" trunks, it is advisable that there should be as many horizontal rows of spring-jacks on the intermediate board as there are sections on the "A" board, and also that each such row should contain the spring-jacks forming the terminals of the fifteen "A" trunks belonging to a given "A" section, as in this way a glance at the intermediate board instantly conveys information as to the distribution of incoming work among the various sections of the "A" board. In like manner the lower portion of the intermediate board contains the plugs forming the permanent terminals of the division of the "A" trunks running to the "B" board. These plugs are similarly arranged in rows corresponding to the "A" trunk plugs on the "B" board with the exception, however, that each "B" board contains but ten "A" trunk plugs, hence each horizontal row of plugs in the intermediate board should preferably contain ten plugs. It is found by experience that during the busiest hours, two sections of the "A" board will handle all the incoming business of three sections of the "B" board when operated to its fullest capacity, and as all sections are designed to satisfy maximum demands, exchanges are so laid out that there are two "A" sections to each three "B" sections. The upper portion of the intermediate board, therefore, contains fifteen times as many spring-jacks as there are sections to the "A" board, while the lower portion contains ten times as many cords and plugs as there are sections to the "B" board. Frequently, the first two or three "A" trunks of each section of the "B" board will be grouped together and plugged on to the spring-jacks forming the terminals of the "A" trunks leading to two sections of the "A" board; at other times three given "B" sections that are very busy will be trunked to two given "A" sections while the business of the remaining "B" sections may be such that one "A" operator can handle the business of half a dozen or more "B" sections, etc. No delay in answering calls or otherwise is occasioned through the use of the intermediate board.

The "Express" system, as at present used in San Francisco, is operated through intermediate boards as described, and their use has always given perfect satisfaction, but it is now believed that equal satisfaction and greater simplicity will be derived by dispensing with their use and connecting the "A" trunks of given "B" sections to given "A" sections permanently. When this is done a red lamp on the "B" board can be connected in series to the proper red lamp on the "A" board, thus enabling them to be lighted simultaneously and thus dispensing with the use of the trunk line clearing indicator or relay on the "B" boards, as shown.

VII.

Listening keys (shown as *H* in Figure 6) are used for cutting "A" operators' instruments on any particular section of the "A" board into the lines of such calling subscribers as the "B" operators may extend over to the "A" board. "A" operators and boards alone are provided with listening keys, hence only "A" operators can converse with subscribers.

Order wire keys (see *F*, Figure 6) are also placed on "A" boards alone, and may best be described as exchange service keys. Their function is to enable any "A" operator to speak with the operator of any desired "B" section, and they are used for such service exclusively. Each order wire may be considered as originating permanently in the head telephone of the "B" operator for a given section of the "B" board, whence it continues to the corresponding order wire key of each "A" section. Order wire keys bearing corresponding numbers—that is for corresponding sections of the "B" board—are wired in multiple, and as the keys are normally in open circuit, and as each "A" operator is provided with an individual order wire key, any "A" operator may call up any "B" operator at will by depressing the proper order wire key. "B" operators, therefore, can be called only by "A" operators; hence they cannot call up any subscriber or any operator. They have no means for listening to conversations between

subscribers and can talk only with such "A" operators as may call them up over the order wire. "A" operators to the contrary, as has been shown, can cut their instruments into conversations over subscribers' lines passing through their boards, or into circuit with any "B" operator at will.

Subscribers' "Express" equipments are arranged for full metallic service, as shown diagramatically in Figure 7, illustrating the simplified circuits of the system when

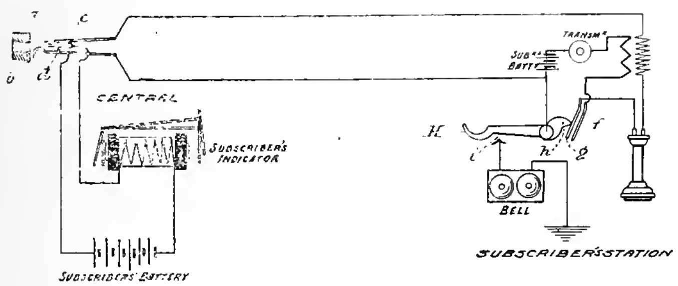

Fig. 7.—The "Express" System.—Diagram of Subscribers' Station, Spring Jack and Self-restoring Annunciator Indicator.

the receivers are off the hooks and the instruments are in use. The weight of the receiver on the hook *H* depresses it, maintaining an open circuit between the hook point *h* and the springs *f g*, at the same time grounding one side of the line through the magneto call-bell at the point *i*. Upon raising the receiver from the hook, however, the ground is taken from the circuit and call-bell by breaking the contact *i*, and the line circuit is completed by the pressure of the hook point *h* against the springs *f g*, which closses the local battery circuit through the transmitter and the primary of the induction coil, and also closes the line circuit through the receiver and the secondary coil. As described elsewhere this closes the subscribers' battery circuit that is always upon the subscribers' line when in use, and thereby transmits the subscribers' call to the proper indicator on the "B" board. The action of the hook, therefore, closes the subscribers' line when in use, and opens it when idle with the telephone on the hook.

VIII.

The automatic indicators, which form a characteristic feature of the "Express" system, give continuous visual indications from which the operators ascertain the condition of each and every circuit at a glance. Their scope of utility is most comprehensive, for they not only relieve the public from any responsibility in calling up central or in ringing off, but they faithfully subserve every function hitherto performed by operators in restoring indicators, testing for "busy," listening for responses, ascertaining if conversation is yet in progress, or in looking after renegade subscribers who are never known to "ring off." Moreover, through their use it becomes impossible for operators to make mistakes in switching without having their attention called to the error. Beyond this a further advantage in the use of visual indicators rests in the fact that in relieving operators of the labor of listening to ascertain when the line is clear, the indicator system enables them to restore the lines when clear with far greater celerity than can possibly be done otherwise. As a result a greater number of subscribers can be handled over a given number of trunks cleared by visual indicators than will be possible by any other means.

These indicators are conveniently arranged on both "A" and "B" boards, and are actuated by the calling and called subscribers respectively when they have completed the conversation and have replaced their telephone receivers on the hooks. Inasmuch as the act of switching requires the momentary attention of three operators, namely, an incoming "B" operator, an "A" operator, and an outgoing "B" operator, it is necessary that each operator should have reliable and instant notification of work to be done and concerning the condition of all circuits under her control. Accordingly, the chief functions of indicators are: First, to notify the proper operator of the existence of a call; second, to warn of improper switching or the failure of a subscriber to respond, and third, to convey such information as is necessary to enable the operator to ascertain the condition of the circuit until the conversation has ceased and it is time to clear the lines. All this is done automatically and by visual signals without the slightest effort on the part of any operator in cutting into lines, listening for conversations, or without a ringing-off signal by the subscriber or any manual effort whatever on the part of any one.

The operation of a reliable and comprehensive system of indicators is best accomplished through the placing of the indicators with their accompanying battery and balancing coils across the conductors of a trunk line. This is done in the manner shown in Figure 9, where the indicator battery and retarding or balancing coil are placed across the "A" trunk. The indicator is connected to the tip side of the trunk, that is, to the wire leading to the tip side of the trunk plug, while the retarding coil is connected to the opposite or sleeve side of the trunk with the indicator battery in circuit between the indicator and retarding coil, thus preserving an inductive balance on each side of the battery. In order that the automatic signalling of a calling subscriber when he has completed a conversation should not interfere with the automatic signals sent to the outgoing "B" board by the called subscriber at the same time, the condenser shown as *C* in Figure 9, and which has a capacity of one microfarad, is inserted in the indicator side of the "A" trunk, which breaks the metallic conductivity of the wire, but not its telephonic or inductive continuity. In no other portion of the "Express" system are condensers used. It is obvious, then, that the presence of the condenser

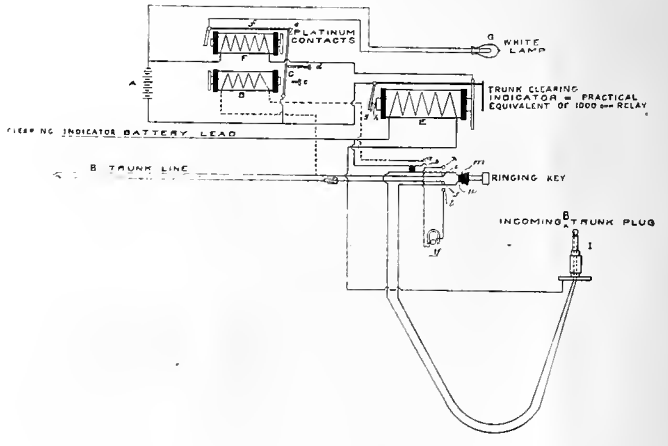

Fig. 8.—The "Express" System.—Diagram of "B" Operator's Indicators.

in the "A" trunk will prevent the indicator battery from completing a circuit through any device placed beyond the condenser; hence the indicator current on the "A" trunk does not reach the spring-jacks on the "A" board, but is confined to the "A" trunk and the line and circuits of the calling subscriber. Similarly the indicator circuit of the "B" trunk is entirely independent of everything

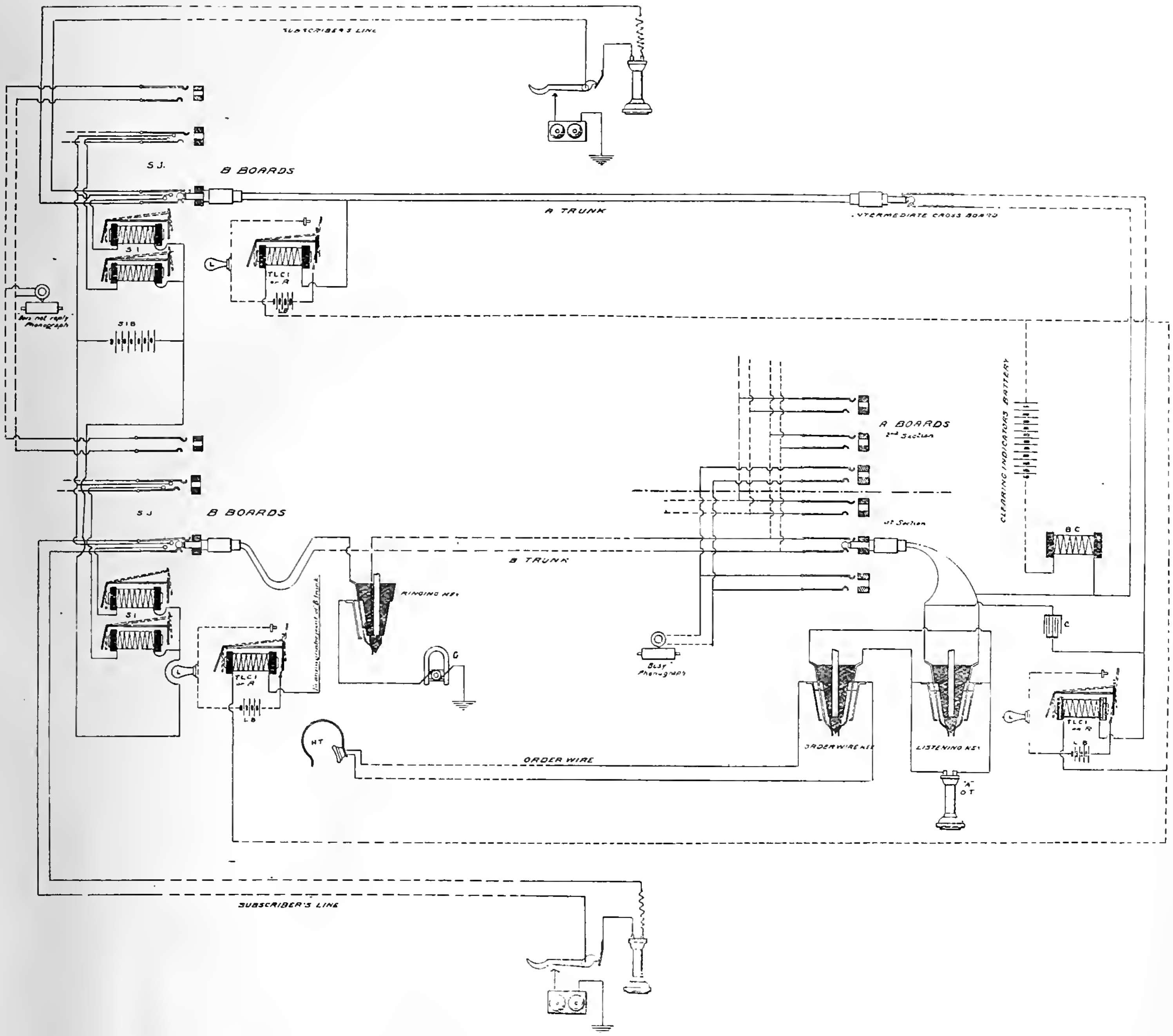

FIG. 9. SIMPLIFIED DIAGRAM OF THE "EXPRESS" SYSTEM.

REFERENCES—*T. L. C. I. or "R.," Trunk Line Clearing Indicator or Relay.—S. J., Subscriber's Spring-jack.—S. I., Subscriber's Indicators. S. I. B., Subscriber's Indicator Battery.—H. T., Head Telephone.—C., Condenser.—B. C., Balancing Coil.—L. B., Local Battery, "A" O. T., "A" Operator's Telephone.—G., Ringing Generator.*

except the "B" equipment. In practice the indicator battery is in closed circuit through the various instruments upon the subscriber's line during conversational use, but as the current is exceedingly small, seldom exceeding one milliampere, its presence is found to be entirely neglected, even in long distance telephoning.

The methods by which the indicator lamps on the table of the "A" switchboard are actuated are clearly set forth on Figure 10, which shows the table complete except the order wire keys, but as the functions and connections of these have been fully explained, and as they cut no figure in the operation of the indicator lamps, the omission is of no consequence. In addition to the order wire keys, the table of the "A" board contains four sets of devices each in a row which are named in order, commencing with the front of the board and individually described as follows:

First are the listening keys, which rest in their normal condition when standing vertically when the operators telephone is cut out of circuit and a secondary contact in circuit with the white indicator lamp is closed.

Second are the white indicator lamps, which are set into the table in the manner shown, and when lighted designate the "A" trunk plug upon which is an unanswered subscriber's call. The battery operating the white lamp may be broken either by the act of a calling subscriber in placing the telephone on the hook, by the "A" operator in lifting the trunk plug containing the subscriber's call from the plug receptacle, or by the "A" operator in depressing the listening key in order to cut her instruments into circuit. In this connection it should be noted that the actuation of indicators whether of annunciator form or miniature lamps invariably occurs

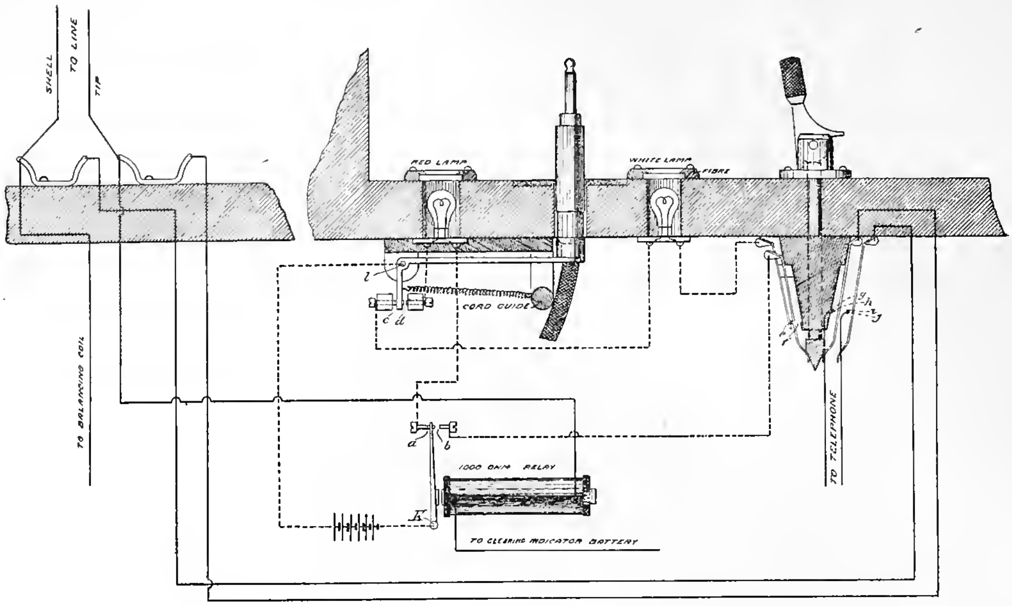

Fig. 10.—The "Express" System.—Table of "A" Switchboard, Showing the Circuits Controlling the Indicator Lamps.

through the performance of a function that is usual in making switch connections, such as the lifting of a trunk plug from its receptacle or the cutting in of an operator's telephone into a subscriber's circuit, etc. In actual work the operation of the white lamp is of a converse nature to that just described: the calling subscriber having lifted the telephone from the hook, sends the subscriber's battery current to the "B" board thus actuating the subscriber's indicator. The operator in charge of the incoming "B" board plugs the "A" trunk line into the subscriber's spring-jack which cuts off the subscriber's battery as previously explained, and at the same time closes the circuit actuating the indicator on the "A" board for that particular trunk through the subscriber's instruments. The indicator circuit being closed lights the white indicator lamp designating a call as stated, and this lamp remains lighted until the call receives attention, when the depressing of the listening key opens the lamp circuit and extinguishes the light. Moreover, should the operator accidentally pull out a busy plug, the returning of such plug to its receptacle would light the white lamp designating it, and so afford instant notification of the error committed.

Then in the third row are the plugs forming the terminals of the "A" trunks which appear behind the white indicator lamps, but their use requires no further description than that already given.

In the last row are the red lamps which form the ringing off or the clearing indicators for the trunk plugs they respectively designate. Like the white lamps, they are, under normal conditions and as described elsewhere, under the control of the calling subscriber so far as their lighting is concerned and also in that they are extinguished when the operator has performed her duty.

Under the table of the "A" switchboard are placed three pieces of accessory apparatus, two of which, the listening key switch and the plug receptacle or gravity switch, are controlled by the operator, while the third is a 1,000-ohm relay energized by removing the subscriber's receiver from the hook and demagnetized by replacing the receiver upon the hook. This relay controls the lighting of the indicator lamps on the table and the operator controls their extinguishing through the ordinary use of the listening key and the trunk plug in switching, as shown. The primary object of the listening key is to cut the operator's instruments into the calling subscriber's circuits, which can be done by drawing the key forward, thereby closing the contacts *g h* and *i j* respectively, which also separates the points *e* and *f*, for the battery circuit for the white lamp. It is plain, then, that if the white lamp is lighted the cutting of the operator's instrument into the calling subscriber's line, as must be done in answering a call, will extinguish the light. The trunk plug rests in and its weight bears down a receptacle forming the long arm of a right angle lever at the fulcrum of which *l*, is connected one side of the lamp battery. The short arm of the lever has two platinum points near the end, which with their respective circuits form the contacts *c* and *d*. When the plug is idle its weight closes the contact *c* in circuit with the white lamp, but when the plug is in use its receptacle is raised by the spring, closing the contact *d* in the red lamp circuit. The red and white lamps are alternately thrown into circuit, but not necessarily operated, by the use or non-use of the trunk plug. The armature of the relay forms one lever of a simple two-point switch, the fulcrum K of which is connected to the other side of the lamp battery while the back contact *a* is in direct connection with one side of the red lamp, and the front contact *b* is in similar connection with the white lamp.

The normal condition of the equipment of the table of the "A" board is as shown in the drawing, and the instant the calling subscriber lifts his receiver from the hook the operator in charge of the incoming "B" board notes the call and plugs it on to the "A" trunk, the other end of which appears as the plug shown in Figure 10. This act on the part of the "B" operator cuts out the subscriber's battery and restores the subscriber's indicator on the "B" board, and simultaneously the indicator battery, being on the "A" trunk as explained elsewhere, is thrown on to the calling subscriber's line, but as this has been closed by the subscriber in taking his receiver off the hook, the indicator circuit is thus completed through the 1,000-ohm relay shown in the drawing. The relay armature springs forward, closing the circuit of the white lamp through the contacts *b e f c*. The light

quickly attracts the attention of the "A" operator, who presses forward the listening key indicated by the burning of the white lamp, and asks "Number." This act opens the circuit of the white lamp at the points *e f*, and cuts in the operator's instruments at the points *g h* and *i j*. Having ascertained the numbei wanted, the listening key is restored to its vertical position, cutting out the operator's instruments and again cutting in the white lamp. The operator then depresses the proper order wire key, as elsewhere explained, and having ascertained from the outgoing "B" operator the number of the "B" trunk to be used, the "A" operator lifts the plug indicated by the white lamp and inserts it in the spring jack of the "B" trunk designated. The raising of the plug opens contact *c*, which extinguishes the white light, and closes contact *d*, restoring the battery circuit to the wiring of the red lamp, so that when the calling subscriber hangs his receiver on the hook the opening of the indicator battery circuit influences the relay and releases the armature. The contact *a* is thus broken. the contact *b* is closed aud the red lamp is lighted, signifying that the conversation is ended and that the lines are ready for clearing. The "A" operator thereupon removes the plug from the "B" trunk spring jack, the plug drops into its receptacle, the red light is extinguished and the circuits are again in normal condition so far as the "A" board is concerned.

X.

It has been shown how, on the incoming "B" board where a subscriber's call originates, the call is made manifest by the dropping of the subscriber's indicator shutter, and how that shutter is automatically restored when the operator plugs the call over on the "A" trunk to the "A" board. It must now be clear how the "A" operator receives both calling and clearing signals, and when it is stated that the clearing signals are made to appear on the incoming "B" board simultaneously with their appearance on the "A" board, through the placing thereon of a relay-indicator wired in multiple with the one-thousand ohm relay on the "A" board, it will be equally clear how the clearing signal on the incoming "B" board is given. The "B" board relay-indicator is the practical equivalent of the one-thousand ohm relay on the "A" board with the exception that it controls only the clearing indicator and therefore has but a single contact point shown as *g*, *h*, in Fig. 8.

The action of the "B" operator's indicator on the outgoing board will be understood by reference to Fig 8. The ringing key contains three sets of contacts by means of which the sides *m n*, of the "B" trunk plug may be thrown in contact at once with the points *i. j*, forming the terminals of the "B" trunk, or with the points *k*, *l*, constituting the poles of the magneto M.

In its normal position the ringing key is as shown in the drawing, when the trunk line continues uninterruptedly to the trunk plug, but on throwing the key forward the trunk plug is taken from the trunk line and pressed against the magneto terminals *k*, *l*, which sends the magneto or calling current on the line of the called or outgoing subscriber. Simultaneously with this the ringing key closes the circuit between the points *a*, *b*, which actuates the lower magnet B of the compound relay shown in the drawing and illustrated in Figure 6 as I. The magnet B attracts the armature C from the back stop *c* to its core when the act of the operator in taking the magneto current off the subscriber's line breaks the circuit of the magnet B at the points *a*, *b*, and the armature C falls back closing the lamp circuit at the point *e*. This point is platinum tipped and constitutes the means for the closing of the circuit of the battery A to the white lamp G. The lamp remains burning until the called subscriber takes the receiver off the hook which closes the circuit of the indicator battery as shown elsewhere and actuates the trunk clearing indicator shown. This is the indicator illustrated as D in Fig. 6 and previously referred to as the practical equivalent of the one-thousand ohm relay in use on the "A" board, and it will be noted that when energised its single contact points *g*, *h*, will be closed throwing the local lamp battery A upon the upper magnet *f* of the compound relay, which results in the raising of the lever *f* liberating the armature C and opening the circuit of the white lamp at the ratchet point *e*. It will thus be seen that the "B" operator is fully advised of the condition of the line of the called subscriber even though she has no means of cutting into the circuit and listening to conversations. The lighting of the white lamp indicates the proper transmission of the call to the called subscriber and the subscriber's response thereto is indicated by the extinguishing of the light. The conversation being finished, the called subscriber replaces the receiver

Fig. 11.—The "Express" System.
Subscriber's Set Complete.

on its hook thus opening the circuit of the indicator battery and restoring the trunk clearing indicator. The operator being thus informed that the conversation is ended, pulls the plug from its spring-jack which takes the indicator battery off the subscriber's line and places the subscriber's battery thereon, thus restoring the "B" board and the subscriber's line to their normal condition.

XI.

An interesting feature of the "Express" system lies in the use of storage battery exclusively for all exchange purposes and the advantages accruing from this proceedure are most pronounced. How this is done, will be best explained by describing the system as actually

operated by the Pacific Telephone and Telegraph in San Francisco to-day. The telephone system of San Francisco comprises about 5700 subscribers, apportioned between five exchanges, as follows:

Main Exchange..............	3000	Subscribers
East Branch Office..........	800	"
South " "	800	"
West " "	800	"
Mission " "	300	"
Total,	5700	Subscribers

The subscribers of the Main Exchange are handled either through the Main office or through one of its three sub-offices, respectively known as the "Drumm," "Front" and "Grant" sub-offices, and each sub-office contains only "B" equipments that trunk through to the Main office with the same facility and practically under the same conditions that would prevail were they located in the operating room of the same exchange. These five exchanges and three sub-offices, constituting eight offices, are located throughout the city, at distances varying from one to three miles from the main exchange, and are all operated from two sets of storage batteries in the Main Exchange.

Each of these batteries contains eight 150 ampere-hour cells connected in series, one of which known as the subscriber's battery, operates the subscribers' lines and indicators of every telephone in the city, and the other battery, known as the indicator battery, operates all indicators, except subscribers' indicators, in the eight offices named.

As originally installed, the subscribers' and indicator circuits of each "Express" section in San Francisco, were operated from open circuit battery, each such circuit requiring twenty cells, and each such section being independent of all others. Although this arrangement gave no more trouble than ordinarily occurs in the use of open circuit battery, it was not deemed sufficiently satisfactory, and gradually each section of the switchboard was thrown upon the accumulators until now the entire system has been so operated for over eighteen months. The battery circuits are distributed to the various branch and sub-offices by circuits of No. 10 B. & S. bare copper wire supported on poles, and an astonishing feature is that considering all demands including leakage, the output of the subscriber's battery for the entire system of 5700 subscribers varies between one and one-and-one-half amperes, never exceeding two amperes, while the current output of the indicator battery is but five amperes during the hours of heaviest service, all at about 18 volts. The maximum output of these batteries is therefore, but 126 watts, the cost of which compared with the cost of operating the system by open circuit batteries, is insignificant. The service rendered by the accumulators is moreover infinitely superior to that from other batteries.

XII.

Remembering that the permanent terminals of all subscriber's lines are located as individual spring jacks on "B" boards, each subscriber's line having but one such spring jack in the whole exchange, and that the chief functions of each "A" operator are: (1) To ascertain from the calling or incoming subscriber the number of the called or outgoing subscriber and (2) to close the ends of such subscribers' circuits as the "B" operators in charge of the sections containing the permanent spring jacks of the calling and called subscribers respectively, may extend over to her section of the "A" board; and assuming that subscriber No. 409 desires to converse with subscriber No. 1510, the modus operandi of switching in the exchange will be as follows, it being further assumed that both subscribers are located in the same exchange.

The act of the calling subscriber (No. 409) in taking the receiver off the hook will send a call in on the "B" board which will be received on the 400 section and indicated on subscriber's indicator No. 409. The operator in charge of the section says nothing to any one, but extends the line of the calling subscriber over to the "A" switchboard by inserting the plug of an idle "A" trunk into spring jack No. 409. This simple act automatically restores the subscriber's indicator on the "B" board and lights a white indicator lamp on the "A" board designating the particular "A" trunk plugged in and indicating that an unanswered call is thereon. The call being thus transferred to the "A" board, the "B" operator receiving the original annunciation is relieved from listening to the call and from any further effort whatever in completing the switch, unless, perhaps, the called subscriber happens to be on the same section.

The "A" operator presses forward the listening key which cuts her instruments into the "A" trunk designated by the lighting of the white indicator lamp and also into circuit with the calling subscriber whom she asks "Number?" and who replies "1510."

The "A" operator raises the listening key to a vertical position, thereby cutting her instruments out of circuit with the calling subscriber and then depresses the order wire key connecting her instruments with the head telephone of the "B" operator in charge of the 1500 section of the "B" board; that is, the section on which is located the terminal of the lines of the called subscriber.

The "A" operator next calls the number wanted to the outgoing "B" operator in charge of the 1500 section of the "B" board, the conversation between the two operators being carried on over the order wire exclusively, entirely free from the subscriber's circuits. The "B" operator notes that "B" trunk No. 3, for instance, is idle and saying to the "A" operator "On 3," places the plug forming the terminal of "B" trunk No. 3 into the spring jack, forming the terminal of the line of the outgoing subscriber (1510), while simultaneously the "A" operator places the plug forming the terminal of the "A" trunk designated by the burning of the white indicator lamp and on which she has received subscriber No. 409, call into the spring jack forming the terminal of "B" trunk No. 3, thus completing the circuit from the calling subscriber's instrument to the "B" operator of the section of the "B" board upon which terminates the line of the called subscriber.

This completes the switch so far as the "A" operator is concerned as she is not required to supervise the call or to ascertain if the party called for answers. It is upon the outgoing "B" operator that this duty devolves and after having plugged the "B" trunk into the spring-jack forming the terminal of line 1510 which completes the circuit through from the calling subscriber to the called subscriber, the "B" operator depresses the ringing key and throws the magneto or calling current on to the called subscriber's line. This act also lights a white miniature incandescent lamp on the "B" board indicating to the operator that the call has been properly transmitted. When the subscriber responds by raising the receiver from the hook the lamp is extinguished and the clearing indicator is thrown showing that the line is in use. Thus is given positive information as to whether the subscriber has been called and has or has not responded (in which event he will be rung up again) or whether he is using the line. Upon completing the conversation the called subscriber

replaces the telephone on the hook which restores the clearing indicator and informs the outgoing "B" operator that the conversation is finished and that the line may be restored. The operator is thus enabled to determine at any and all times the condition of the line.

The red lamp indicators on the "A" and incoming "B" boards will show for disconnection when the calling subscriber has completed the conversation and replaced his telephone. The plugs of the "A" trunk of both the "A" and "B" boards are then removed from the spring-jacks by the respective operators and are allowed to drop into their sockets, which extinguishes the red lamps. It will thus be seen that the switching of the line of the calling subscriber on to that of a called subscriber requires the momentary attention of the "B" operator; the incoming "B" operator receiving the original call, instantly plugs it over to an "A" operator and gives it no further attention whatever, until the lighting of a red indicator lamp gives notification that the conversation is ended and the plug is to be pulled from its spring-jack. The "A" operator takes the call and transfers it to the outgoing "B" operator in charge of the section on which the called subscriber is located which completes the "A" operator's part of the switching until the burning of the red lamp notifies her that the plug may be withdrawn. The outgoing "B" operator merely closes the final gap between the ends of the subscribers lines and ascertains by visual signals whether or not the called subscriber has responded, which together with removing the plug at the close of the conversation, completes her duty. By this means the work of switching is evenly divided between "A" and "B" operators, and the handling of calls in even the largest exchanges may be done with great facility and perfect satisfaction, with apparatus much less expensive than that ordinarily used.

XIII.

An innovation both practicable and interesting which has been first applied with success in the "Express" system consists in the use of phonographs for the notification of calling subscribers when their calls cannot be answered because of "busy" or of the failure of the called subscriber to respond. In the main exchange are two ordinary office phonographs, the tube of each of which is connected to an individual solid back long distance transmitter by means of the soft rubber tubing ordinarily used in phonograph work, the tubing being centered in a membrane drawn tightly over the mouth-piece of the transmitter. One of these phonographs, known as the "Busy" phonograph, speaks the words "Busy, call again" incessantly, and the other, known as the "No reply" phonograph, says "Subscriber called for does not reply," in an equally industrious manner.

The secondaries of the induction coils for the phonograph transmitters are carried to the sections of the proper switchboards in multiple, that is, the secondary of the "Busy" phonograph appears on each section of the "A" board in the form of a spring jack, and the secondary of the "No reply" phonograph appears on each section of the "B" board also in the form of a spring jack. To illustrate the use of the apparatus: if subscriber No. 409 desires subscriber No. 1510 and the outgoing "B" operator notes that 1510 is busy, she merely says to the "A" operator over the order wire, "busy," and the "A" operator simply inserts the plug forming the terminal of the "A" trunk into the phonograph spring jack. Subscriber No. 409 then hears the words: "Busy, call again," from which he understands that No. 1510 is engaged in conversation elsewhere, and that he is to call up the party again later. He then hangs the receiver on its hook which actuates the indicators and the lines are cleared as at the end of a conversation. The other phonograph throws out the words: "Subscriber called for does not reply," on the calling subscriber's instruments after the outgoing "B" operator finds that she cannot ring up the called subscriber and when she places the plug forming the terminal of the "B" trunk into the phonograph jack. The clearing indicators are then actuated as before.

These two phonographs operate the entire exchange and their use relieves operators from a material amount of labor in conversing with subscribers who soon learn that the phonograph has an exemplary disposition and that "sassing" it is productive of no particular amusement or gain.

There yet remains a feature of the Express system that works great economy in the cost of installing a system by reason of eliminating the necessity of carrying subscribers' lines, whether on aerial or underground circuits, through to the exchange individually. This is accomplished by the establishing of semi-exchanges, known as "sub-offices" in various sections of business districts and terminating subscribers' lines in such sub-offices. Only "B" boards are located at these points, and the "B" operators in sub-offices trunk through to "A" operators in the main exchange over "A" trunks with the same facility and rapidity that they would do were the sub-office "B" boards located in the main exchange. Branch offices differ from sub-offices in that they contain "A" boards as well as "B" boards. They are therefore complete exchanges.

XIV.

The problem of expediting the handling of subscribers' lines in exchanges is tantamount to any presented to the telephone engineer for solution, and the means by which is at once accomplished the greatest facility and satisfaction yet attained in switching, is in the use of the trunking system. This is noteworthy, as trunking has generally, from the earliest days of telephony, been looked upon at best as a necessary evil. The express system is essentially a trunking system throughout, whether installed in main, branch or sub-offices, or whether used between either of these offices, but it is, in reality, an elaboration rather than a modification of trunking in its familiar sense. It seems quite improbable that communication may be established between two subscribers by means of devices requiring the momentary attention and actions of three operators, with more facility than can be done by a single operator upon whose board is found the terminals of the lines of both the calling and called subscribers, and whose practically only act is to loop the lines together. In an abstruse sense this would be an impossibility, but the latent factor which resolves the situation into an established fact rests principally in the training that the telephoning public unconsciously receives from the use of an appliance run on such strict business principles as is the Express system. The subscriber soon learns to respond to the ringing of the bell without a moment's delay, or otherwise he will lose the call, and having done so he is cognizant of the fact that whatever business the calling subscriber had to transact will be lost unless the calling subscriber rings up again. In other words, the policy of the express system is that subscribers must attend to their own business and not rely on central in any manner for reminders of business that has not been attended to.

The extraordinarily favorable results obtained with the Express system, as exhibited in the accompanying plots (Figures 12 and 13), showing the average time of local and trunked connections respectively on the switchboards in No. 1 office, San Francisco, in the Milk-street office, Boston, and in the Cortlandt-street office, New York, graphically portray the various acts that consume time in switching. The plots are so very clear that no detailed explanation of them appears necessary beyond the statement that the Express system is used in San Francisco, while the Boston and New York offices are equipped with modern multiple

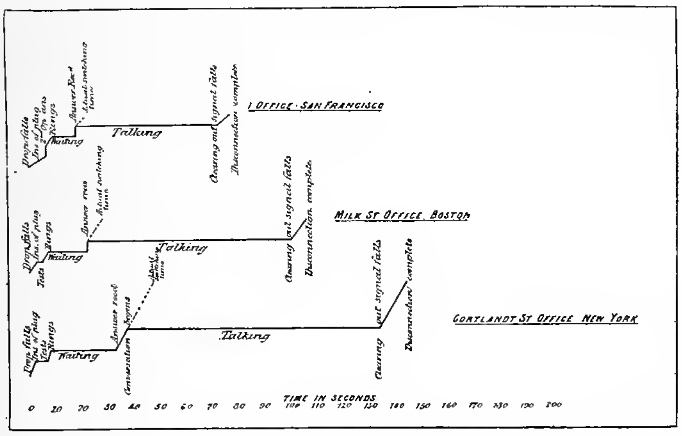

Fig. 12—Plot Showing Average Time of Local Connections on Telephone Switchboards—San Francisco Using "Express" Boards, and Boston and New York Using "Multiple" Boards.

boards. The data from which the charts were made was collected by Mr. Theodore Spencer, the well-known telephone engineer of the American Bell Telephone Company, which places their accuracy above question.

It may be well, however, to call attention to a few sapient points that the charts emphasize. As stated, the San Francisco office being equipped on the Express, or essentially trunk system throughout, presents the same record in making local connections as in making trunk connections, but the time consumed in the old form of trunking common to multiple board systems, and as shown in the Boston and New York characteristics, forms a very serious item. The waiting period on the multiple board also considerably exceeds that indicated for San Francisco, which is largely due to the reason given, that when a subscriber on an Express system hears a call he must make it his business to respond. With the multiple system, however, the called subscriber realizing that the calling subscriber does the ringing, will take his time in responding. In brief, a large proportion of the time consumed in switching in multiple systems is due to the slowness and indifference of subscribers in executing the acts that they are expected to and must perform. The advantage held by the Express system in this regard rests, therefore, in the fact that the public has no duty whatever to perform except to remove the receiver from the hook when called and to replace it thereon at the close of the conversation.

A peculiarity of the diagrams is in the different lengths of the talking periods, varying from 54 seconds in San Francisco to 110 seconds in New York, and in this connection a regret may be expressed that similar characteristics are not at hand from Chicago in order that the propriety of that hated charge of "windiness" may be forever settled in the findings of a strictly scientific and unprejudiced investigation.

XV.

The expediency of equipping a telephone exchange with this or that system resolves itself into the old question of commercial practicability—the issue that so unrelentingly condemns the fond but visionary hopes of many inventors. All untried schemes must be considered in the light of ventures, but this article deals with systems that have been demonstrated by hard practical use to be reliable and of commercial utility. Comparisons are not odious when improved conditions result therefrom, hence there is no objection to showing as briefly and as succinctly as is possible, the relative advantages and disadvantages of the two systems that must soon compete for supremacy in the equipment of telephone exchanges, whether large or small. The relative merits of "Multiple" and "Express" systems are as follows:

The "Multiple" Switchboard. *Advantages*—1. A single operator completes the entire switching, hence the greatest possible simplicity in working.

Disadvantages—1. Complexity in switchboard wiring; hence

2. Excessive first cost, and
3. Excessive cost of maintenance.
4. Incurs an objectionable increase in the electrostatic capacity of the subscribers' lines because of the enormous amount of switchboard wiring.
5. Injury to a single section by fire, water or otherwise, renders the entire exchange inoperative until repaired.
6. The great number of working contacts creates a serious liability of trouble because of the occurrence of open circuits in the old style board and of short circuits in the new style board.
7. The necessity of applying a manual test for "busy" before a switch can be made.
8. Difficulty of locating switchboard troubles.
9. Excessive cost of making additions, each of which requires not only the adding of a new section, but also the making of additions to the lines of each subscriber entering the exchange.
10. High rates of insurance because of ready susceptibility to damage by fire and water.

The "Express" System. *Advantages*—1. Low first cost; being not in excess of one-third that of a multiple board of equal capacity.

2. A single terminal for each subscriber, securing absolute simplicity in terminal wiring on the board.

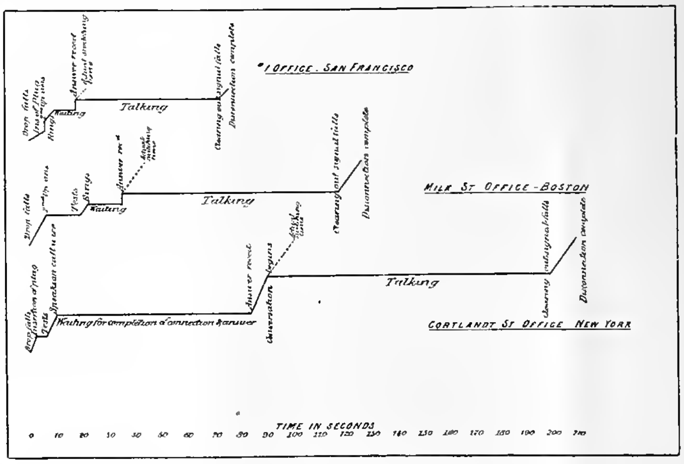

Fig. 13.—Plot Showing Average Time of Trunked Connections in Telephone Switchboards—San Francisco Using "Express" Boards, and Boston and New York Using "Multiple" Boards.

3. Elimination of the troubles consequent to a great number of working contacts in multiple or in series.
4. Absolute independence of each section from all other sections.
5. Minimum cost of maintenance.
6. Ease of locating switchboard troubles.

7. Automatic visual signals relieve operators from all testing, listening for responses, etc.

8. Impossibility of rendering the whole exchange inoperative because of injury by fire, water or otherwise to a single section; hence

9. Low rates of insurance because of minimum susceptibility to damage by fire or water.

10. Ease and comparative inexpensiveness of making additions, since the cost of a switchboard increases directly with the size.

11. It is an all-trunk system.

12. Highest rapidity yet attained in exchange switching.

13. All signals from subscribers are transmitted automatically, hence with unfailing precision.

14. Enables the establishing of sub-offices, as described, thereby reducing the investment in line wires or underground cables oftimes enormously.

Apparent Disadvantages—1. The services of actually three, and practically two operators are required to complete each switch.

XVI.

The "Express" system has established the fact of its superiority over multiple switchboards, which have hitherto been conceded to be the only means by which the business of large exchanges could be handled to any degree of satisfaction. San Francisco, the home of the system, has tried it long and thoroughly. Electrical engineers whose names are bywords in the world of telephony have visited the city by the Golden Gate that they might themselves examine the system claimed to be superior to the multiple system, yet which had ventured to depart from the lines of construction universally accepted as correct, and having examined it, have been satisfied, and they too confirm its worth. Now Chicago, true to the spirit that has made its name a synonym of progression, is displacing the old method with the new. The telephone world will watch the change with interest, but even so it cannot be said that the "Express" system is in the balance, for it has been weighed and not found wanting.

Educational.

ELECTRICAL ENGINEERING AT THE UNIVERSITY OF CALIFORNIA.

The courses in electrical engineering for the University of California come under the heading of the Department of Mechanical Engineering, of which F. G. Hesse is Professor of Mechanical Engineering, Frederick Slate, B. S., is Professor of Physics, Clarence L. Cory, M. M. E., is Assistant Professor of Mechanical Engineering, L. F. Chesebrough is Instructor in Mechanic Arts and in charge of machine shops, and J. N. Le Conte, M. M. E., is Assistant in Mechanics.

The lectures on electrical engineering are delivered by Professor Cory, and will be upon the following subjects during the academic year of 1895–96:

ELECTRICAL MACHINERY. Construction of electrical batteries and measuring instruments, and their selection for special testing. Discussion of the design and construction of continuous-current electrical machinery; its application to electric lighting and power distribution. Laboratory tests and designing.

ELECTRICAL ENGINEERING.—(*a*) *Alternating Currents and Alternating-Current Machinery.* Theory, generation and applications of single and polyphase alternating currents; effects of self-induction and capacity in circuits; discussion of the construction and design of generators, transformers and other alternating-current apparatus.

(*b*) *Electricity in Engineering and Principles of Electrical Installation.* Discussion of the design, equipment and management of electrical stations; electric lighting, telegraph and telephone circuits; long-distance transmission of power by electricity from water power, and special applications of electricity to industrial purposes.

(*c*) *Electrical Laboratory and Designing.* Practice in the laboratory and draughting-room, illustrating the work of the classroom.

The degree of Electrical Engineer was conferred upon the following graduates of the term just closed: H. W. Corbett, Ch. J. Fox, Olcott Haskell, R. B. Hoffman, J. E. Strachan.

ELECTRICAL ENGINEERING AT STANFORD UNIVERSITY.

Believing that American practice has justified the separation of the Electrical Engineer from the Electrical Manufacturer, and that it has defined the Engineer to be one who is engaged upon the solution of practical problems by the aid of obtainable apparatus, the Electrical Engineering courses of the Leland Stanford Junior University, as shown by the Register for 1894-5, just issued, have been planned for the constructor of engineering work rather than for the manufacturer of machinery. While keeping this aim in view the rapid changes in the profession have not been lost sight of, and the underlying principles of correct design are dwelt upon to such an extent as well fit the Engineer to arrive at just decisions on the merits of established or proposed methods.

The classes in Electrical Engineering are under the instructorship of Prof. F. A. C. Perrine, D. Sc., assisted by Mr. Farmer, and the Undergraduate Courses consist of lectures in (1) Constructive Materials and Machinery, (2) Application and Design, (3) Central Station Design and Management, (4) Engineering Construction, and (5) Recent Applications of Electricity.

Special Graduate Courses will be offered in a series of lectures by Prof. Perrine on (6) Dynamo Machinery Design, (7) The Theory and Practice of the Design of Inductive Apparatus, (8) Telegraphy and Telephony, and (9) Special Applications of Electricity.

Entrance examinations for the next semester begins on Monday, Sept. 2d.

The following class is the first to matriculate the full four years in Electrical Engineering at Stanford: Arthur Hardin Burnett, Tulare; Benson Clare Condit, Riverside; Robinson Crowell, San Francisco; Paul Milton Downing, Palo Alto; Elmer Elsworth Farmer, Palo Alto; Donald Hume Fry, Arcata; Ernest Chesney Hayward, Victoria, B. C.; Walter Spalding Hyde, San Francisco; James Terry Langford, Lodi; Roland Harry Manahan, Pasadena, Maurice William O'Brien, San Jose; Thomas Henry Pomeroy, Oswego, Or.; William Henry Reeves Jr., Seattle, Wash.; Edmund Carmel Southwick, Mayfield; Harry Clinton Thaxter, Palo Alto; John West Thompson, Redwood City; George Lyman Woodworth, Palo Alto.

THE NATIONAL SCHOOL OF ELECTRICITY.

Mr. F. D. Wallaker has recently been appointed Western Agent of the National School of Electricity, with headquarters at Denver, Colorado, where, in a brief time, a class of ninety-five was organized with Mr. Irving Hale as Instructor and Mr. Lewis Searing as Chairman. It is announced that the organization of classes in San Francisco and elsewhere on the Pacific Coast will be commenced at an early date.

The Electrical Journal.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

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EDITORIAL.

LET ACTIONS SPEAK.

The Electrical Journal is instituted in the belief that the publication of a strictly first class paper, devoted to the industrial applications of electricity, gas and power, will find a welcome and prove a profitable undertaking. It extends no assurances other than of accuracy, independence and impartiality, and knowing that the goal of success it hopes to reach can only be attained through intrinsic worth, it realizes that it will be judged by its works rather than by its promises.

Technical journalism is so done and overdone that the publication of a new paper is regarded, if not with suspicion, at least with wonder. What reason has this journal for existence, and what can it have to say that is worth hearing? It is said of every new venture of the kind that some one has discovered or thinks he has discovered a workable field of patronage. Is it this and nothing more?

But consider the promoters in a more friendly vein for a moment, and it may be that they shall prove themselves worthy of confidence. It is true that all men who are doing the world's work are specialists, and the more each man specializes, the more successful that man becomes. But few indeed can make discoveries or inventions along many lines; nay, even how many are able to study and apply all there is which bears upon one line, or even one point of a single line. The dynamo tender needs the aid of the electrician, the electrician of the physicist, and he in turn must look for assistance to the chemist, the mechanical engineer, the civil engineer, and the manufacturer, as well as to the mathematician and the philosopher. All men's work, therefore, bears upon each man's specialty, and all men must hope to obtain from the journalist the "news" of what the others are doing that they may carry their own work on to its completion. Does any technical journal fulfill this task for its branch completely? We believe not, and judge there yet is room for a new journal, and that new men will have something of service to offer.

The value of a new journal to its readers will depend upon its command of authors capable of telling in an authorative manner of what has been done, and what is doing, and what is to be done. Perhaps the editors may add but little of value to the work of the writers, but the earnest they give is that they will offer the fruits of faithful gleanings from wide fields of experience, investigation and research.

Neither creed or belief then shall receive further discussion, nor shall any hope be expressed but that this venture will merit both confidence and support through the attainment of its aims of honesty and breadth and helpfulness.

ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

Two papers have been read at the informal dinners held by the Pacific Coast members of the American Institute of Electrical Engineers during the past winter which have excited sufficient interest to lead to the belief that in part at least they are worth preserving. The first paper, presented by Dr. F. A. C. Perrine, discussed "The Technical Training of an Electrical Engineer for Practice on the Pacific Coast," and the second on "The Field of Operations of an Electrical Engineer," was delivered by Mr. E. J. Molera. The last named paper, which is reprinted elsewhere in this issue, was designed as a reply to the doubts expressed by a member at the previous meeting as to the usefulness of the many trained engineers now entering the electrical profession, and the writer most completely defines the field of the engineer which makes him truly an engineer and not merely an artisan—a man with skill to build and a foundation to build upon.

Dr. Perrine began by calling attention to the fact that the electrical engineering education in most of the technical schools is aimed to fit a man to be primarily a designer of electro-dynamic machinery or a manufacturer, and little attention is devoted to fitting men for positions when their principal duties consist in the design and erection of engineering works or for acting in the capacity of advisers to choose between the various methods of solving engineering problems. It is left to the future training obtained in the shops of the manufacturing companies to develop these capabilities and there the utmost care is taken that as much of bias for one system shall be given as is possible. Such training leaves the engineering undertakings on the Pacific Coast

at the mercy of the great manufacturers, and indeed the bias given to engineers trained in this manner forms the principal subject of adverse comparison of our electrical engineering with that in England and on the Continent recently made by Mr. H. Ward Leonard.

We have not here the manufacturer of general electrical appliances, nor many shops for repairs or laboratories for the standardization of instruments and the successful engineer amongst us must be trained to be ready with wit and skill to correct all sorts of deficiencies in the apparatus furnished him and to avoid many accidental obstacles. In fact, our needs call for a universality of talents and training which is perhaps impossible to obtain completely except as a born gift, but with the aim of producing the self dependant man and with a knowledge of the material at hand our education must approach their ideal.

The student on the Pacific Coast is, as a rule, a man who depends upon his own resources for support, not only after his years of training, but often before and during these years, and it is rarely that he has received the most complete preliminary instruction. His technical education must, therefore, begin with a most thorough course in mathematics, physics and chemistry, and in later years a choice must be made between the complete study of electro-dynamic machinery and the study of branches more distinctly connected with engineering construction.

With a view to the practical needs of the Pacific Coast engineer it, therefore, seems most wise to educate the men to be as competent critics as is possible of machinery and methods proposed by the manufacturer and to train them at once for the duties of engineer to plan and erect engineering undertakings.

CONCERNING JOURNALISTIC VENERABLENESS.

It is not altogether an uninteresting diversion to see three leading electrical papers chafing over the time-worn moot-point of venerableness, as from information at hand it would appear unquestionable that our esteemed prototype, the Electrical Engineer is really the "oldest" publication as it claims, and that our newsy friend, the Electrical Review, is entitled to the distinction of being the "oldest weekly." As for the "Pioneer" journal, Webster defines the word as expressing "one who goes before to remove obstructions or prepare the way for another," or, in plainer terms, a pioneer is one who steps aside that another may pass on. It is advisable then, if there must be a controversy, that it be confined to the journals named, or the third must either alter its plea or stand convicted on its own evidence.

The Electrical Journal rests content in the knowledge that no one can dispute the claim that to-day it stands as the "newest" electrical publication in America, if not in the world, and here again the same authority sapiently defines the word "new" as "recent, fresh, modern."

Clearly then the motto of The Electrical Journal shall be: *"The Newest Electrical Publication in America."*

Literature.

A Manual of Telephony, by William Henry Preece, F. R. S., Engineer-in-Chief and Electrician, General Post Office, and Arthur J. Stubbs, Technical Officer, General Post Office, London, 1893: 508 pages, 8 vo., cloth, fully illustrated. For sale by The Electrical Journal. Price, $4.50, post free.

There is perhaps to-day no more up-to-date manual for telephonists than the work which forms the subject of this review, yet this expression of endorsement is not unqualified for in truth no book which has yet appeared contains a full and complete exposition of the workings of the modern, well-equipped telephone exchange of today. But this perhaps is not to be hoped for considering the marvellous development in telephone exchanges, and considering that in no country has the handling of subscribers' lines settled down to clear cut, well-defined practices. Preece and Stubbs' work is indeed, more than all others, a manual that will be appreciated by all telephonists, whether in large or small exchanges, and experimenters will find it of historic and practical value. The authors, having had exceptional facilities for investigating the commercial side of telephony, have not hesitated to give a generous share of their experiences to their readers in the shape of circuit diagrams generally drawn to scale, formulae, and such data and specifications as will enable the experimenter to deduce dimensions for the construction of an induction coil giving maximum intensity and clearness of sound in a telephone, for instance. Equally well will it enable the line foreman to effect the greatest possible neutralization of induction by the arrangement of wires on his pole lines, as also will it enable the engineer to determine the capacity of lines under given conditions or on the limiting distance of speech. In brief it forms a universal handbook of telephony, complete to its date. The tendency to favor description of English practices, and particularly that of the British Post Office, is pardonable, but the authors frankly admit their partiality when in the preface they say:

"Telephony, in the broad principles of its practical application, tends increasingly to become cosmopolitan; so that, although English practice generally is more specially described, Continental systems are not excluded, and the principal points of practice in America—the home of the art—are fairly represented."

A conscientious adherence to the idea which seems to have been held by the authors that there is a need for a publication concerning the practical applications of the art of telephony has made the work what it professes and is commended to be, "A Manual of Telephony," more full and complete than any yet published.

The Electric Current; How Produced and How Used, by R. Mullineux Walmsley, D. Sc. (Lond.), F. R. S. E., etc.: 754 pages, 379 illustrations, 8 vo., cloth. Published by Cassell and Company, Ld., London, and for sale by The Electrical Journal. Price, $3.00, post free.

Here is found in a single, handy volume, a reasonably comprehensive exposition of each and every application of the electric current in the service of man, together with descriptions of the various processes by which electrical energy may be produced. The work is divided into three distinct parts, treating of the Production, the Laws and the Applications of the Electric Current, respectively, each of which forms a more than elementary manual of information concerning that portion of the science to which it is devoted. Evidently the author appreciates the fact that readers of electrical literature have had a surfeit of historical matters or descriptions of the phenomena of Electrostatics, for these themes are dismissed after having received such

brief consideration as is reverentially due them in a work of this character. In fact a similar consideration is shown all through the book, and if the author has a hobby in the production, the laws or the applications of the electric current, he has most skillfully concealed it, as his writings bear no evidence of partiality or favoritism to any particular branch or theory. Each is given such consideration as its importance demands. The book cannot be considered as elementary, for it treats of matters beyond the first principles of the science, although first principles are fully expounded, nor can it be classed in the catalogue of advanced treatises on electro-technology: instead it forms a happy medium that deserves popularity, at least because it is a volume that, while not aspiring to encyclopædic proportions, yet contains in clear, concise and simple language an explanation of the basic principles of each and every application or relation of the electric current, whether information is desired concerning chemical reactions, metallurgy, telephony, polyphase transmission of power or even the fire-fly's secret.

Electricity as a Fire Hazard, by W. J. Jenks. A paper read before the World's Fire Insurance Congress, Chicago, June, 1893. Paper, 73 pages. Published by the General Electric Company, presumably for gratuitous distribution.

In presenting this book to the public the donors have performed a service meriting the appreciation of all who are interested in the common weal. Ordinarily there is so much of the mysterious about electricity in the minds of the public that any successful effort in the way of enlightenment from that unfortunate condition deserves commendation. Such is a characteristic of Mr. Jenks' valuable paper, which is, in reality, a comprehensive review of the technical side of electro-insurance relations during the past sixteen years, freely elaborated with the views of the author. A reasonable inference is that the paper, being published by an electric company, is designed to further the interests of the corporation fathering it, but despite this, the book is free from bias, and presents the various hazards of the applications in a clear lucid way and with profuse colored drawings. It is a book for fire underwriters as well as for electrical men, and its publication cannot but remind insurance interests that their own efforts to restrict the fire hazard of electricity are no more sincere and earnest than are those of the legitimate electrical fraternity.

THE EFFICIENCIES OF ELECTRIC PLANTS.

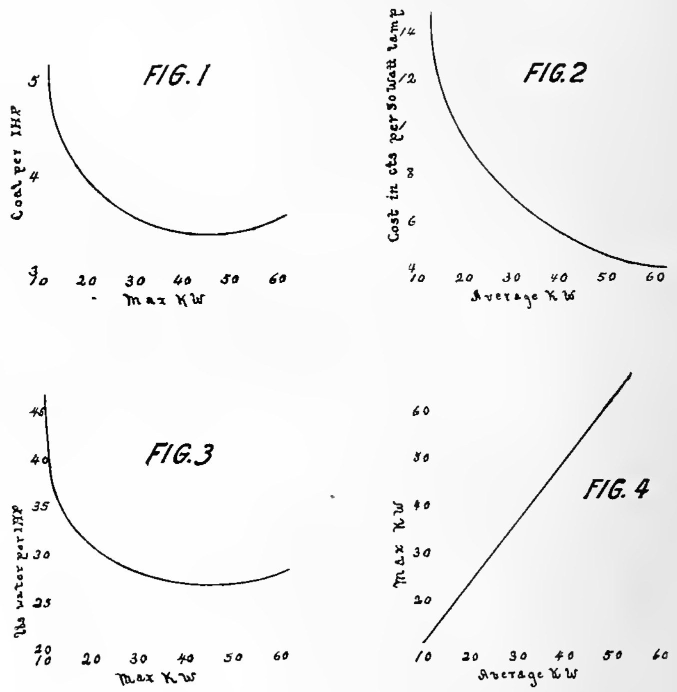
By Sydney Sprout, E. E., M. E.

I.

Believing that by far too little has been published concerning the economic features of the operation of plants for the generation of electricity, the writer proposes to contribute from time to time as the exigencies of business will permit and as occasion may be presented, such data as may be obtained by actual experiment under actual working conditions, of plants coming under his observation. There will be no effort to make these contributions consecutive for the reasons stated, but the object will be to give *facts* whenever opportunity is presented for unearthing them.

The writer, in investigating a municipal electric lighting plant with the object of ascertaining the actual cost of producing electric energy at various stages of load, compiled the accompanying tables, whence were derived the rough curves also accompanying. Having thus obtained fundamental data it was thought best to go further into the matter than was originally designed, although it has not been the object to go into the finest details of operation, in fact the circumstances of the test would not permit the most minute investigation. Nevertheless the results will be interesting for comparisons that I hope will be brought out during the course of these articles.

The lighting plant herein discussed is equipped with both arc and incandescent dynamos which are about equally divided as to the power required for the operation of each system; consequently the cost of labor is



The Efficiencies of Electric Plants.

divided equally between the two systems, or to put it another way, the cost of attendance for the incandescent system is but one-half of what it would be were there only an incandescent machine in the station. This fact not only explains why the item of labor is quite small, but also reduces proportionately several other factors of expense included in the final results.

The equipment consists of two 75 h. p. tubular boilers, two 12x16 automatic high speed simple engines, each rated at 90 h. p. with 240 revolutions per minute and 90 lbs. of steam. These engines were, however, run but to 215 R. P. M. and the engine under consideration is belted direct to a 60-kilowatt alternator supplying commercial circuits, the plant being started in the evening at dusk and shut down at midnight. The other engine is similarly belted to two 60-light arc machines furnishing city street lamps on moonlight schedule.

It may be observed that doubtless many have wondered at the very favorable showing in the way of economy that has been made by some small stations such as this one is, when compared with the larger and better equipped central stations. The results here given for example seem quite low, but when we look at the average load and see that the station is operating under a load factor of 80, while central stations are frequently compelled to run under a load factor as low as 25, the reason for the favorable results herein shown are not difficult to understand.

Returning to the station in hand it will be seen by reference to the curve shown as Fig. 4, that at a maximum load of 60-kilowatts which is not uncommon, the average load is 48-kilowatts, and in the station in question it is found that the cost of producing energy

per 50-watt lamp hour at this stage of load will be \$0.0048. On the other hand, in the case of the central station and reducing it to a common ratio, a maximum of 60 kilowatts would bring the average down to but 15-kilowatts which will show the cost per lamp to be three and three-tenths cents per hour. This shows that a station that can run only during the hours of heavy load in the evening, has very great advantages in the way of economical operation over a station that renders continuous service twenty-four hours a day, which is a point that should not be lost sight of by owners of electric plants, whether in isolated or central station work, in their anxiety to deliver to their tenants or patrons a continuous lighting service. It has often been wondered why some small stations equipped with more or less uneconomical apparatus can manage to exist. We know that they do so and that some of them are in apparently healthy condition and offer service during limited hours at prices that well equipped large modern central stations can not afford to meet, but when we consider a station equipped for an output of 40,000 lights and which delivers only about 5000 lights 18 hours out of 24, there is no longer reason for doubting the statements of the central station managers. The station from which was derived the data given, is operated with the highest economy attainable, not only because of the unusual reductions in the items of labor etc., but also because of the fact that the maximum capacity being 60 kilowatts, the average load is 48 kilowatts, which is shown by the water and coal curves to be the most economical point at which the steam plant can be worked.

The results given in the table were obtained by carding the engines at different periods and at different loads, and by actual measurement of the water and coal consumed. The cost of labor etc., represents the actual outlay, and from the data thus derived the remaining results were calculated and checked by means of accepted engineering formulæ.

a	b	c	d	e	f	g	h	i	j	k	l
K. W.	$b = \frac{a}{746}$ E. H. P.	I. H. P.	Lbs. Water Per I. H. P.	$e = \frac{a}{c}$ Watts Per I. H. P.	$f = \frac{d}{7.9}$ Coal Per I. H. P.	$g = \frac{c}{a} \times f$ Coal Per K.W. H.	$h = f \times .288$ Cost of Coal Per I. H. P. hour	$i = g \times .00288$ Cost of Coal Per K. W. Hour.	$j = \frac{3.80}{a}$ Wages Int. and Repairs per K.W. Hour.	$k = i + j$ Total Cost Per K. W. Hour.	$l = \frac{k}{20}$ Cost per 50 Watt Lamp
15.4	20.60	35.60	34.00	432	4.30	9.89	1.24	2.85	24.67	27 52	1.380
19.8	26.50	39 60	32.00	500	4.05	8.10	1.17	2.30	19.19	21.49	1.074
24.2	32.40	43.56	30.00	555	3.80	6.84	1.09	1.97	15.70	17.67	.883
25.3	33.90	45.50	29.50	555	3.70	6.62	1.06	1.33	15.07	16.40	.819
28.8	38.60	49.50	28.30	582	3.60	5.61	1.03	1.61	13.19	14.80	.800
35.1	47.00	57.80	27.60	607	3.52	5.77	1.01	1.66	10.82	12.48	.686
39.9	53.58	65.93	27.50	606	3.47	5.61	.99	1.61	9.52	11.54	.577
42.2	56.54	70.29	27.40	600	3.46	5.74	.99	1.65	9.02	11.01	.550
48.8	65.48	83.16	27.00	576	3.41	5.79	.98	1.67	7.79	9.87	.493
52.2	69.79	88.11	27.50	592	3.47	5.76	.99	1.66	7.29	9.42	.471
55.5	74.23	94.04	28.00	590	3.54	5.98	1.02	1.72	6.84	9.30	.434
62.2	81.98	100.98	28.50	621	3.60	5.76	1.04	1.66	6.28	8.36	.418

THE EFFICIENCIES OF ELECTRIC PLANTS.

ON THE FIELD OF OPERATIONS OF AN ELECTRICAL ENGINEER.*

BY E. J. MOLERA, M. A. I. E. E.

It is a law of Nature that all developments shall be done by infinitesimal steps; so that, from the first conception of an idea to its practical application to the needs of man, years of evolution have to pass before the powers that be take hold of it as an acceptable acquisition to the valuable fund of man's possessions.

The electric telegraph as a rapid transmission of intelligence to complement rapid transportation, was the first great application of electricity to the wants of man which demonstrated the great possibilities of that comparatively new resource of his power over Nature.

But not until a few years ago when the economical conversion of mechanic power into electrical energy was effected was it possible to enter into the field of every day's necessities by means of electricity in competition with older methods. The dynamo was employed to produce light and other commercial commodities, and in connection with the telephone, which by a fortunate coincidence was perfected at the same period, created such a confidence to capital that Electricity was a magic word in the world of science as well as in the world of finance.

Then it was when from every profession recruits were drawn to develop the new field of enterprise: the telegraph operator, the mechanical engineer, the manufacturer and technologist, all gave their contingent to the army which was to exploit the new Industrial fields, and they accomplished so many new, rapid and unexpected achievements that the great professors in Electricity were no less astonished than the masses of the people. It was then that the new profession of Electrical Engineering was created.

*Abstract of a paper read at the Informal Dinner of the Pacific Coast members of the American Institute of Electrical Engineers, San Francisco, April 27, 1895.

That imperative call for talent and the splendid success achieved by some of the votaries of the new art created such a rush to supply the demand until now, the former is fully equal to the latter and there is danger of a surfeit of supply. The problem then, today, is how to prevent such undesirable result, by finding new fields of labor for the new comers rather than by discouraging the candidates of the new profession.

The young man fresh from college has unfortunately a great idea of his attainments and consequence and very little knowledge of the stern realities of life. There are few positions good enough for him, and, hearing that there is always room at the top of the ladder, endeavors to reach there with a jump, forgetting that those who were lucky enough to attain that eminence did so step by step, and many times after long and severe struggles.

The sooner he has his conceit knocked out of him the better for his success. He must learn that no amount of explanation will teach a man to swim, and in order to be in it he must obtain perfection with practice. He will find out how easily a man forgets the prescriptions of books and teachers, and how firmly facts are retained when bought at the dear price of experience. Let him understand that success means ability and application. That he must have some of the first and supplement it with the second; that he must acquire method and accuracy in order to obtain thoroughness; that he must work details as carefully as he does the principal parts of his work. He must not disdain little things; and not try to do everything at once:

> Let us be content to work,
> To do the thing we can, and not presume
> To fret because it's little. 'Twill employ
> Seven men, they say, to make a perfect pin.
> Who makes the head consents to miss the point;
> Who makes the point agrees to leave the head;
> And if a man should cry "I want a pin,
> And I must make it straightaway, head and point,"
> His wisdom is not worth the pin he wants.
> —Mrs. Browning.

Having the above philosophy in mind, he may enter the field of electrical engineer to give the battle of his life. The avenues are many. As a votary of electricity there is hardly a man's want in which this young daughter of Science cannot be usefully applied, and in which room for improvement cannot be devised. But as his object probably will be of an immediate necessity he can better devote his attention to those departments which are now already organized, and though under the same field are more or less distinct and separate.

He may chose the department of electro-postal engineer, electro-mechanical engineer, electro-municipal engineer, electro-constructing engineer, electro-industrial engineer, electro-consulting engineer, professor of electricity and inventor. Unfortunately the electrical engineer, unlike the lawyer and the physician, does not come in contact with the consumer of the productions of his brain. The nature of the forces in which he deals invites the man of capital to take control of the promising discoveries and pass them through the modern commercial manipulations of corporations and trusts with their shares and bonds, debenture and otherwise, preferred and common stock with paper scattered broadcast to catch the guileless investor. The engineer entering these big engines of trade is appreciated in proportion to his power to bring profits to the company and dividends to the stockholders. Hence the efficiency and real merit of the products of his talent are often ignored and the cheapness and attractiveness of the goods are preferred.

There was a time when the electrical engineer was the constructor and dealer of his own inventions. The houses of Siemens, of Germany and England, Gaspar, of Belgium, Sautter et Lemoinier, Breguet and others of France are conspicuous examples. But to-day the Edison, Thomson-Houston, Westinghouse and other trusts and companies only mean great aggregations of capital used to boom their interests, using the names of those distinguished inventors as money-making means. Sometimes it happens that in order to consummate their financial operations they keep from the public knowledge improvements achieved by the inventors under whose name they operate.

But we are not considering here the evils of modern economy but the field of the electrical engineer.

If he should chose to be employed as electro-postal engineer he will probably engage in the telegraphic or telephonic departments. Perhaps there is no place today more unpopular for an electrical engineer than the telegraph operator, and yet from that department some of the most prominent engineers originated: Edison, Gray, Chandler, Field and so many others. His opportunities to exercise his knowledge will be numerous. The whole range of battery work and different multiplex system will engage his energy, no matter how great it may be. Should he be employed in telephonic work, before him he will see the problems of greatest distance telephony, as well as trans-oceanic transmission, waiting to be solved, and in both departments the utilization of earth currents for means of transmission of intelligence.

Very little need be said of the field of operations of the electro-mechanical engineer. Aside of the amount of knowledge he must use in the proper employment of metal, whether iron or copper, the proportion of the different parts either in dynamos or motors, how much ingenuity is needed in giving a garb to the skeleton of the machine, its stability, its bearing, etc. One only needs to consider the amount of ingenuity exercised in such a simple machine as a bicycle wheel to see the importance of details. What applies to dynamos and motors applies to cars, to lamps, to all other products, electro-forging, welding, stamping, electrical transmission—all are in his field.

I call an electro-municipal engineer an engineer which I consider should exist in every city of importance. In the same way as we have now a County Surveyor, a City Engineer and a Superintendent of Streets, there should be an officer who should represent the city in all matters relating to electricity. The safety of buildings from fire requires that the houses using electric light or power should be properly wired; the same applies to motor-cars. The tracks of electric roads when used, as is usual for return circuits, should be of sufficient size and metallically bonded in their whole length. You have seen from the reports of Messrs. Stuart-Smith and Adams the damages that can be done to the property of other city corporations.

The field of the Municipal Engineer, aside from being the adviser of the city authorities, has under his care the lighting of streets and warming of buildings, the electrical care of the Fire Department, the suburban communication, the under-ground conduits, the distribution of power for small industries. I call electro-constructing engineer the constructor of small electrical machines and measuring apparatus. The essential part of an engineer is the accuracy of his measures; the ultimate object of his work is the best and most economical use of the forces at his command, and for that purpose he must have the greatest assortment and most reliable measuring instruments. No amount of ingenuity and labor are excessive in the designing and construction of such instruments. This department is of such importance that Lord Kelvin has said: "Accurate and minute

measurements seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but rewards of accurate measurements and patient, long-continued labor in the minute sifting of numerical results."

I have given the name of electro-industrial engineer to the one whose energy is devoted to the manufacture of commodities by means of electricity. I might have called it electro-chemical engineer with equal propriety.

Chemistry in modern times has worked a revolution in the production of commodities. What formerly was obtained by man directly from the great laboratory of nature is now in many instances manufactured in the laboratory of man with greater convenience to himself. Foods and beverages; paints and dye-stuffs; metals; materials of construction; fertilizers; medicines; illuminants and articles of all descriptions are prepared by the chemist. It is a remarkable fact that nearly every chemical operation can be done, as far as tried, by electrolytic processes, and in most cases with greater ease and economy. This field of operation is yet in its infancy; the precipitation of all metals from their solutions; the manufacture of chemical products, like chloride of potash, bleaching liquids and caustic soda; the purification of water; disinfecting of sewage; refining of sugar; tanning and many other processes are now already in his field.

The Electro-Consulting Engineer is the one who by original training and subsequent experience is able to advise on any subject in electricity, can design and make plans on the same and superintend the carrying out of them. It is the goal of all young engineers, and none excepting those whose reputation rests on achieved results should undertake this most important branch of Electrical Engineering. His field is every application of electricity and has room to employ every power of his brain every hour of his time and every effort of his energy.

The Professor is born, not made. No amount of learning will make a professor if he has not the faculty of imparting it to others. He must be plain and direct in his statements, patient with his pupils and have that human magnetism which attracts the attention of men and retains their respect and affection. We must remember that the best teaching is by example, and if he besides the above qualities has practically exercised the branches he is to teach, the field of his operations is the most important and the good he does to others of incalculable value.

As a money making pursuit, teaching may not be the most desirable, but the opportunities for scientific research and original work given to the professor in the use of fine instruments and leisure time are full of compensation for other losses. Necessity is the mother of invention. Invention is one of the most uncertain means of satisfying the necessities of the inventor. By the universal law of evolution inventions are developed by degrees so that an invention, we may say, floats in the air before crystalizing into substantial form. It is no wonder that when in the race for glory and profit an inventor reaches the object of his labors, if it be promising of adequate reward, many dispute his claims, and the Government protection, which in many cases protect only the powerful and the wealthy, is put in operation to deprive him of his dues. Under the circumstances a young engineer should not employ his energies in that *ignis fatuus*, but, as many other things, all do it, he must prepare himself well, before entering the grandest and most seductive of all fields of thought. Even after he has mastered the knowledge of many facts and the laws governing them, he may not be rewarded in his efforts to create.

There are some men whose minds are similar to sponges—which will absorb knowledge as sponges do water; but when they bring forth what they have absorbed it comes as it went in, without change or addition to what they first acquired. On the other hand, other minds seem to naturally gather facts, divine laws and force effects spontaneously. Nothing comes to the region of their knowledge without being digested and assimulated to their minds, there to be transformed into new ideas to originate ways and means for the applications of the forces of nature to the wants of man. These are the born inventors. But even they cannot accomplish great things without a good store of facts and knowledge of the laws of Nature.

There are two kinds of inventions: Those new processes of using the laws of nature that fulfill pressing necessities of men and which, on account of their novelty and their extended application, revolutionize existing methods, and those improvements which without changing the existing processes, perfect them. The latter are the most numerous, the best to undertake and generally the most productive. The former are the most difficult and seldom to be undertaken.

In the matter of invention the first thing that the would-be inventor should do is, to establish clearly in his mind the element of the problem before him.

Which are the things that man at the present moment most desires? Are they at the present time already supplied? If so, can they be supplied better and cheaper than they are now? Does the proposed invention imply a theoretical impossibility according to the best knowledge of science at present?

When he has chosen the object of his investigations, then he must acquaint himself with all the processes, if there be any, employed in accomplishing what he wants to improve; and if not, everything similar to it in other branches of science and arts.

Knowing that what he proposes to do would be an improvement on existing methods, that it does not contradict the conservation of energy and in other respects is not a heresy of science, he then can formulate his plan of accomplishing it, in a new and better way, whatever problem he desires to solve.

After that comes the experimental trial; it will propably show him deficiency in knowledge or his error in reasoning. It will instruct him in the best and most lasting way and teach him that whenever practice does not go together with theory the latter must be wrong.

Electricity and magnetism have been the last of the forces of Nature utilized by man for his wants.

The reasons are obvious: The most precious things for the existence of man Nature has abundantly supplied: Few minutes without air would kill any mortal; Nature supplies it to him in unlimited quantities at every place without the least effort on his part. Few hours without water would be quite uncomfortable for any one, and Nature again supplies it very abundantly, though he has some time to store it, or has to have some one to bring it to him and pay for it.

He could not subsist without food many days, and though he has to gather it, or cultivate it, still it is easily obtained by him.

Heat is the next requirement and is sufficiently stored in our atmosphere to keep him comfortably in many parts of world and in the others shelter and fuel can also be acquired without great difficulty.

Light is not of such vital importance, and for that reason one half of man's life is kept in darkness.

Man is a most wonderful organism and yet as a testing organism is most imperfect, As a dynamometer,

thermometer, phonometer he is poorly good. A photographic plate can register the impressions of more points of light, say stars, with a simple lens, than man can perceive with the Lick refractor. As an electrometer, whether Ampere or Volt-meter, he is a dead failure.

From creation the paternal sun has been throwing myriads of waves of electricity and magnetism and man was innocent of the existence of either of these forces. It took the genius of the great scientists of the beginning of this century to know something of their nature and make them manifest at their will. Not until half of the century had elapsed, was it found that they were correlatives of heat and light. The century is closing and we only now find out that the same laws of emission, radiation, reflection, etc., that obtain in heat and light, apply equally as well to electricty and magnetism.

Maxwell pointed out the propagation of the electromagnetic wave through ethereal space: Hertz has demonstrated by means of his oscilator and reasonator the existence of such waves and has measurad the time and size of their oscillations, and together with Tesla, Thomson and others have demonstrated the other points of resemblance to the laws of light.

It is in this direction and the thorough knowledge of these facts and theories that will bring forth the greatest number of inventions in Electro-magnetism.

The main departments in which Electricity may be used is as power to overcome gravity, energy to produce heat and light, and as means to promote chemical reactions.

In the shape of evaporation and condensation of the vapor of water and in the heating of the air, we have now two valuable sources of power, viz.: water and wind power. It is known that the potentiality of the atmospheric electricity changes with the distance from the earth's surface and with time. The earth itself is a great magnet, with magneto-electric currents constantly flowing from the equator to the poles. The deviation of the needle and the glow of the aurora clearly show it. Even supposing that its rotation in the ether produces no friction whatever, the great surface velocity at the equator, which is more than 90,000 feet per minute, would in presence of the magnetism of the sun produce great earth currents. Now, do such currents store themselves, as light and heat do in vegetation and the coal measures, or, in some unaccounted way, dissipate through space?

I will not touch the many unsolved problems of light without heat, great heat without combustion, and possibly without light, transmission without metallic conductors, and seeing at a great distance by electrical means. I will come back to the point of beginning—how the opportunities of a young engineer may be improved.

First, by his being prepared to meet the new and increasing demands of electrical application. In the coming wedding of electricity to all the other branches of industries, are the civil and mechanical engineers to acquaint themselves with electrical knowledge to build and operate the future electrical railroads? Is the metallurgist to become an electrician or the latter a metallurgist? Is the chemist to study the properties and effects of the electric current, or the electrician the reactions that follow the combination of the elements of matter in certain proportions and in certain ways?

Electricity is the younger science, is the growing one; it should be enterprising and dispute the field of operations wherever there is an opportunity.

The electrical engineer should now take a stand for his rights, should unite his individual efforts to those of his colleagues and be willing, even if he be at the top of his profession, to stand in with his brother engineers. They all together should teach to the trust, to the corporation and to the citizen, that it is equally as absurd to devise plants for manufacture and stations and to run them without competent and well-remunerated engineers, as it is to build roads without surveys or build houses without architects; that it is equally as absurd to leave the wiring of houses to the contractor as it would the plumbing to the plumber. That it pays to investigate whether or not the cheaper is the best, and that money spent in paying well the conscientious engineer is the best of all economy.

Historical.

THE COLUMBIA'S PLANT DISMANTLED.

After the present month the interest which the veterans of incandescent electric lighting have always felt in the Oregon Railway and Navigation Company's steamship Columbia, will fade, for that vessel is now on the dry-dock at the Union Iron Works, in San Francisco, being entirely reconstructed and its venerable electric lighting plant, which was not only the first ever placed on any vessel in the world, but was also the first plant installed for commercial purposes and placed in the hands of outside parties for operation by the original Edison Electric Light Company, has been torn out and will be replaced by modern apparatus. The history of this most interesting installation has been described heretofore,* but now that the equipment has ceased its practical usefulness it is meet that the event should be recorded.

The credit for conceiving the installation of incandescent lamps on shipboard appears to be due to Mr. Henry Villard, then President of the O. R. & N. Co. and the Northern Pacific Railway Co., a Director in the Edison Electric Light Co. and an intimate friend of Mr. Edison. This was in 1879, when the Columbia was being built at the Cramps' Shipyard, in Chester, Pa., and orders were given that the vessel should be equipped with incandescent lights. At the suggestion of Mr. Edison Mr. J. C. Henderson, then advising engineer of the O. R. & N. Co. and now prominent on the engineering staff of the General Electric Company, was placed in charge of the installation, and that he did his work well, even though in a manner that now bespeaks the crudity of the state of the art of incandescent installation at that time, is evinced in the fact that the plant has a record of service for a period of nearly a quarter of a million hours with no repairs to the machines, it is said, except the rewinding of one field coil, and a few minor repairs to the bearings, etc. So far as can be ascertained the Columbia never lost an armature, and the commutators have received only such attention and renewals as has been necessary from normal and proper usage.

The Columbia's plant consisted of four Edison long field core dynamos of the original type now known as the "Z" pattern. The capacity of each of these machines was 60 16-c. p. lamps, but as only three of them were used for lighting service, the third being utilized as an exciter for the remaining three, the total output of the plant was 180 lights. The vessel was wired for 115 lamps, placed in the cabins and staterooms, but regardless of this fact when the vessel was at sea the four dy-

* Electrical Engineer (N. Y.), Vol. XV, No. 252, March 1, 1894.

namos were operated continuously from dark until 10:30 o'clock each night during the fifteen years the plant has been in operation. The plant was installed in the early part of 1880, and on the 2d of May in that year the dynamos were first started.

In the light of present practices and beliefs it seems impossible that the wiring of this pioneer equipment should have been in use for fifteen years on shipboard exposed to dampness and other possibilities of injury

Relics of the First Marine Incandescent Installation.

without having caused serious trouble, but despite this the No. 11 cotton-covered paraffined wire, which was used for the mains, and the No. 32 cotton-covered paraffined magnet wires used for the branches, all being stapled to the wood work and painted over, remained in serviceable condition to the last. It is stated, however, that originally the plant was installed without fusible cutouts, and that the necessity for cutting off the current by some means upon the occurrence of any abnormal condition in the circuit such as would be occasioned by short circuit, leakage, etc., was impressed by earlier experiences with this plant, and that before leaving for her trip around Cape Horn, the Columbia's lighting plant was provided with safety fuses in the mains near the dynamos and in each lamp socket or at each lamp. All mains and lamp circuits were bunched together, and the main bus wires from the dynamos to the switchboard, or more properly speaking, to the fuseboard, were of bare copper wire stranded and inclosed in a soft rubber tubing, each bus having a strand for each circuit controlled from the fuseboard. The dynamos were driven from a countershaft driven in turn by a pair of high-pressure vertical engines. The countershaft, which was directly over the dynamos, was run along the aftward wall of the main engine-room, and the arrangement of belting between the engines and the dynamos through the countershaft was at a very high angle, in order to economize freight space. A further peculiarity rested in the fact that the armature of the exciter was driven at half the speed of the armature of the lighting machines.

The difficulties attending the first installation of incandescent lighting could be made very clear by an examination of the Columbia's plant. The first lot of lamps installed were of the paper carbon variety, which were so delicate that it was soon found that the jar of the ship's engines broke the filaments at an alarming rate, to overcome which, the lamps were fitted into small turned wood bases and suspended by strips of felt ribbon. Later wood receptacles were used that were placed flat against the surfaces of the ceilings but seperated therefrom by light thick felting to minimize the jar. The sockets wherever used were of complicated type mounted entirely in wood, but the staterooms were lighted by means of lamps mounted on receptacles or the small wood bases described and completely enclosed in ground glass globes so as to be beyond the reach of passengers. These lights could be controlled only by a wooden switch located outside of the stateroom and turned on and off by a key in the hands of the steward. It was necessary, therefore, to ring a call bell and await the response of a steward before the lamp could be lighted or extinguished, and often then it would be necessary to resort to the use of the oil lamp, because of the fact that the regulation of dynamos was such that they could not control the potential under material changes in load. Parts of the lighting apparatus here described are shown in the accompanying illustration.

The incandescent electric lighting plant on the Columbia proved a source of wonderment, not only on the Pacific Coast, but at every port at which the vessel stopped on her voyage around the Horn. Through Mr. Villard's association with Mr. Edison's and the O. R. & N. Co.'s interests, it was arranged that the vessel should stop at every principal port and give exhibitions of the apparatus. The engineers of the Columbia who have been with the vessel from the time it was built, state that the lamps of the paper carbon variety did not outlast much of the trip to the Pacific Coast, and that the replacing of burned out lamps became monotinously frequent. Upon arriving on the Coast, however, a new lot of lamps was received from the East, in which bamboo filaments were used; these gave much better satisfaction and many of them, it is stated, have a record of 5000 hours, while some have burned 9000 hours, and a very few lamps that were seldom used were still connected on the circuits when the plant was dismantled.

In addition to the incandescent plant, the Columbia was provided with a 2000 c. p. power search light operated by a small Siemens' vertical type dynamo with von Hefner Alteneck drum armature. The vessel, when refitted, will be provided with a 400-light Siemens'-Halske generator, direct connected to a triple expansion marine type Union Iron Works engine.

THE HEART AS A PUMPING ENGINE.

Poets and philosophers are fond of marveling at the wonders of the human heart, but they usually confine themselves to homilies on its ceaseless activity, and some of the things that are most wonderful of all escape their attention entirely. One of the most remarkable things about the heart is the amount of work it does. Considering the organ as a pump, the task of which is to deliver a known quantity of blood against a known "head," it is easy to show that in twenty-four hours a man's heart does about 124 foot-tons of work. "In other words," says a contemporary, "if the whole force expended by the heart in twenty-four hours were gathered into one huge stroke, such a power would lift 124 tons one foot from the ground. A similar calculation has been made respecting the amount of work expended by the muscles involved in breathing. In twenty-four hours these muscles do about 21 foot-tons of work.

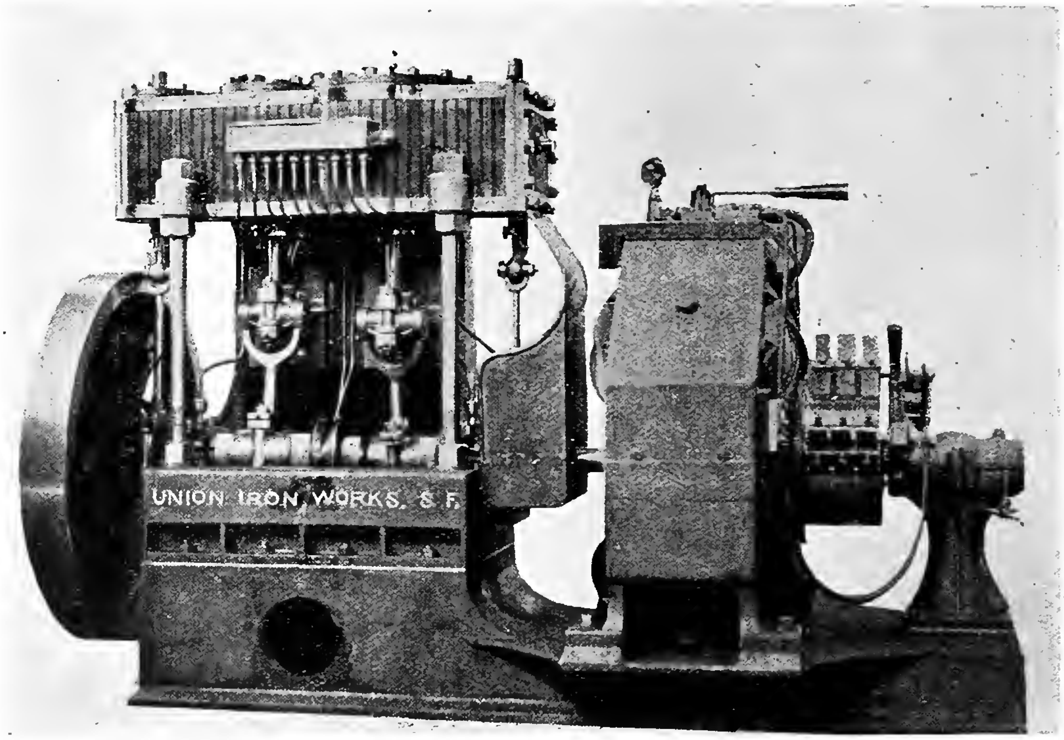
Recent Installations.

ELECTRICITY ON THE CRUISER OLYMPIA.

By W. W. Hanscom, M. E., E. E.

The electrical equipment of the new United States cruiser "Olympia" recently finished by the Union Iron Works of San Francisco, represents a very complete and modern marine plant in every way, and the extent to which electricity enters into the handling of vessels of the new navy could not be more fully expressed than by giving a description of the installation and its various functions. To facilitate description therefore, the various parts of the plant are considered under the following sections:

The Generating Sets, consisting of combined engine and dynamo, directly connected and mounted on a single bed plate as shown in the accompanying illustration, are four in number, each having an output of sixteen kilowatts and forming at once a complete and independent set.



Electricity on the Cruiser Olympia.

The Engines are of the Union Iron Works standard, compound condensing inverted cylinder vertical type developing at four hundred revolutions, twenty-six indicated horse power. An auotmatic governor of the Ide type controls the admission of steam into the high pressure cylinder by acting directly on its valve and so perfect is its action that the variation in speed from no load to full load and reverse is only three revolutions or $\frac{3}{4}$ of 1 per cent.

General Electric Compound Wound direct current four pole marine type generators of eighty volts and two hundred amperes are used each machine being directly connected to its engine. The windings are so proportioned that the voltage varies but $1\frac{1}{2}$ volts from the normal between no load and full load. The armatures are gramme rings with windings of ample capacity to carry an over load of 50 per cent to 75 per cent without injury and when operated under full load for four continuous hours heat 49° F. above the surrounding atmosphere. The commutators are large in diameter and present a large bearing surface for the brushes and are cross connected at 90° requiring but one set of negative and positive brushes.

One of the most interesting features of the installation is the switchboard, which is of slate and designed for eighteen circuits operated by four dynamos. The bus bars and switches are arranged to permit either dynamo to be used separately on arc, incandescent or motor circuits, or for all dynamos to be operated in parallel on all circuits also in parallel. Instrument boards, placed on each side of the main switchboard carry independent Weston voltmeters and amperemeters for each dynamo and search light and also the ground detector. A valuable feature of the switches is the fact that the switch blades are removable when not in use, which reduces the possibility of careless switching.

The wiring is installed under the two wire system, each pair of conductors being carried in wooden moulding with all joints in mains and for branches made in water tight bronze junction boxes; the wires entering through packing or stuffing tubes made tight by soft rubber glands. Where led through bulkheads, the wires pass through water tight stuffing tubes made so in the same manner. The circuits are divided into lighting and battle mains, the former for general illumination and the latter for use in time of action. No single wire larger than 16 B. W. G. is used, larger sizes being stranded to give the required area. The insulation of the wires is as follows: 1st A layer of pure Para rubber 2nd A layer of vulcanized rubber containing about 50 percent sulphur and lastly a layer of woven or braided cotton, saturated with a flame and moisture-proof compound. The average resistance of each outlet to ground including wires, junction boxes and switches and dynamos, after a year's installation and use was sixty million ohms.

The fixtures are all designed with special reference to their respective uses and are finished in dark bronze or oxidized silver according to location. Ceiling rings,

steam tight globes, desk lights and bulkhead fixtures for officers' and crew's quarters, living spaces, engine rooms, passages, etc. together with coal bunker lights, magazine lanterns and brackets, besides water tight switches and receptacles and plain receptacles, are designed with a view to continuous service.

Motors are used for ventlation and ammunition hoisting, the ventilating motors, three in number being arranged as follows: One, a 2 h. p, motor is located in the dynamo room and keeps it supplied with cool air drawn from above the decks. The other two of $\frac{1}{4}$ horse power each, are portables, being arranged to be carried about and used for ventilating coal bunkers, double bottoms, etc. Each motor is fastened to the side of and directly connected to the fan of its respective blower. Three eight horse power shunt wound water proof motors are located in the passing rooms and used for hoisting ammunition to the gun deck for the 5-inch broadside guns, while two five horse power series wound motors with reversing rheostats are located in the turrets and keep the eight inch guns supplied with ammunition

The signaling equipment known as the Electric Night Signaling apparatus consists of a series of double lanterns, the upper halves red and the lower halves white, fastened one above the other on a stay of the main mast; a 32 c. p. lamp in each half is connected to a key board located on the after bridge. Numerous combinations can be made by revolving a handle over an index plate on top of the stand. A truck light, similar in design to the signal lantern is located on top of each mast and connected to and operated by switches on the forward bridge.

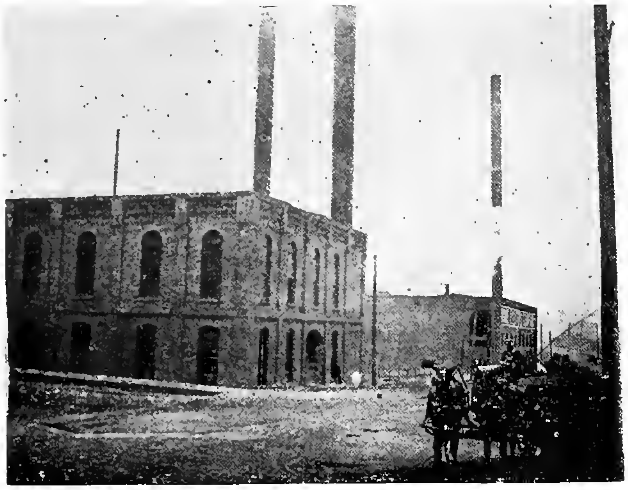
Four Mangin projectors, 30 inches in diameter, are located on the fore and main tops and on the broadsides. These lamps require one hundred amperes each at forty-five to forty-eight volts, the reduction from eighty at the dynamos being accomplished by means of a dead resistance in series with the lamps. Each projector is furnished with two lenses, the inner one forming a hinged door in front of the projector, and the outer one, operated from the back, slides in front of the inner one changing the rays from a parallel beam of great intensity to a diverged or fan-shaped one of more area but less intensity. The lamps, which are arranged for either hand or automatic feed, are so proportioned as to keep the arc always in the focus of the mirror in back. A damper allows of shutting off of the light from the mirror, thus permitting intermittent flashes of light to be used for signaling. The two broadside projectors are, by means of motors and gearing in their bases, controlled electrically by a controlling device in a further part of the ship and can be revolved, elevated or depressed at will. The candle power of the beam is rated at 100,000.

The alarm system consists of hinged floats containing mercurial contacts, located in each water tight compartment and so arranged as to close a circuit when water has found its way to and capsized them. The closing of the circuit operates an annunciator on the main deck, notifying the officers of the location of the trouble. Thermostats in each coal bunker are arranged to give a similiar alarm upon the temerature in any of them rising above 200° F. Electro-mechanical gongs located in numerous parts of the ship and operated by contact-makers similar to a fire alarm box, are used for calling the crew to quarters in case of fire or other reasons.

Interior communication is effected through the use of the push button and annunciator systems and telephones. Calls can be made from one-hundred seventy different points all over the ship and the telephones offer a ready means of communication between the Captain and Chart House, and the turrets and passing rooms and central station. The transmitters are regular granular Hunnings type and are connected in series with the battery, the receivers being used without induction coils. An idea of the completeness of the various systems of interior communication may be had from the fact that it required over 70,000 feet of insulated copper wire or nearly $13\frac{1}{2}$ miles, to make the wiring connections.

A SEATTLE ELECTRIC STATION BURNED.

The electric power station and car barn of the Seattle (Wash.) Consolidated Street Railway Company was destroyed by fire early on the morning of June 20th, causing a loss, roughly estimated, at $100,000. The building was a substantial brick structure, 60 feet by 260 feet in area, occupying the entire side of the block on the north side of Pine street, between Fifth and Sixth streets, and was so constructed on a hillside that the main floor, constituting the car house and repair shop, was on a level with Fifth street, while the basement floor, on which was located the boiler and



engine and dynamo room, was on a level with Sixth street. The photograph from which the accompanying half-tone was made shows the northwest corner of the building, containing the boiler room on the lower floor and the repair shop on the upper floor.

The plant equipment consisted of the necessary boilers and two Corliss engines, each rated at 225 horse-power, either or both of which operated a counter-shaft, driving the six Thomson-Houston type D62 railway generators which the station contained. The building is reported to be completely gutted and in addition to the building and plant the company lost twenty-five cars that were in the building at the time of the fire. An insurance of $40,000 was carried.

The building represented in the foreground of the illustration is the burned station of the "Seattle Consolidated," while that in the background is the lighting station of the Home Electric Company, now consolidated with the Union Electric Company of Seattle.

ELECTRICAL INSPECTION IS NO MORE.

Every employee of the Board of Fire Underwriters of the Pacific except one — Mr. E. F. Mohrhardt, Secretary of the board, has received his demit to take effect June 30th, and only the barren organization will hereafter remain until such time as it may be deemed advisable to adjourn *sine die*, or to reorganize.

Underwriters' electrical inspection in the nine States and Territories of the Pacific Coast is, therefore, a thing of the past, but it is being carried on in San Francisco through the Underwriters' Inspection Bureau.

Electro-Insurance.

LIGHTING FROM TROLLEY CIRCUITS.

The Underwriters' Electrical Bureau of Chicago, acting for the Underwriters' National Elecric Association, has just issued Electrical Fire Hazard Pamphlet No. 3, discussing the hazards of operating lamps and motors by current supplied from electric railways using the grounded trolley system and which is supplemented by letters from many of the principal independent electrical engineers of the country substantiating Rule 41 of the National Code, which reads:

LIGHTING AND POWER FROM RAILWAY WIRES.—Must not be permitted, under any pretense, in the same circuit with trolley wires with a ground return.

The pamphlet points out that this rule was framed by the Electrical Committee of the Underwriters' National Electric Association, and *represents the unanimous opinion of the electrical inspectors of the United States*, and that its enforcement is necessary for the general good as is demonstrated by the numerous fires that have occurred because of its violation, as shown in the various electrical fire reports issued by the Bureau.

The reasons why this system of electrical distribution is far inferior and more hazardous than systems ordinarily used are stated as follows: One side of the circuit is normally grouuded, which means that but *one* accidental electrical connectiou between any part of the wiring and a conducting substance of any nature in electrical connection with the earth, is necessary in order to establish current flow and a resulting "burn out" or fire.

In a complete metallic circuit, *two* such connections are necessary before current flow can be established, and, therefore, the grounded system is considerably more than twice as hazardous as the metallic. The wires of a trolley road being run overhead are susceptible to lightning discharges, and a line being run into a building to a motor and then into the earth, affords an easy, convenient and oftentimes preferable path for the discharge to travel, setting fire to the property on the way. The voltage or "pressure" used on trolley systems is sufficiently high (500 volts) to be classed as a "high potential" under the rules, and the energy used on the circuit is sufficient to necessitate the generation of current quantities frequently great enough to produce very severe heating effects, thus entailing the disadvantages of the series arc system in the comparatively high voltage used, coupled with the disadvantage of the low potential system, which uses large currents, and this results in bringing about enormous heating effects at the point where the break occurs. This is a very hard form of energy to properly control even under favorable circumstances and when traveling over the uncertain path offered by a grounded trolley system, it cannot be considered desirable or safe for introduction inside of buildings. Lightning arresters, extra insulated wire run on large size glass insulators, special fuses, double mounting of the motor, grounding outside the building, a sign reading "danger," a voltage reducer and numberless other proposed safeguards, are advantageous, and each does its little to decrease the probability of trouble, but they cannot make a grounded circuit the equivalent of a metallic circuit from any point of view.

The electrical engineers who coutribute letters condemning the practice in question are Messrs. Pierce & Richardson, J. P. Barrett, Wm. A. Anthony, Stone & Webster, W. M. Stine, Wm. L. Puffer, E. P. Roberts and L. K. Comstock.

ELECTRO-CHLORINATION.

A new process for the extraction of gold at a very small expense is soon to be started at the Gold & Globe Mill of the Cripple Creek (Colo.) Gold Milling Company. The method to be used is known as the "Electro-Chlorination Process," and although certain parts of it are held secret, it is known that the idea is based on the passing of a heavy current at low potential through crushed ore immersed in a solution of sodium chloride. The sodium and chlorine are separated under the action of the current, the chlorine uniting with the gold, forming a chloride of gold which is deposited on a sheet of lead or other suitable cathode.

The deposition vat will consist of a large tank, the bottom of which is to be lined with blocks of carbon to a thickness of about three inches. Above these carbon blocks, which form anodes, will be spread the ore crushed to about a sixty mesh, upon which is poured the solution of sodium chloride, and on the surface of the liquid is supported the cathode. The dynamo used will have an output of 6,000 amperes at 20 volts, and it is claimed that on ton lot experiments, 94 per cent. extractions have been made in 45 minutes. The secret part of the process consists in the use of an ingredient which, when added to the sodium chloride solution prevents the liberated sodium from re-uniting with the chlorine

All experiments have hitherto been carried on in Philadelphia, and having proven successful, a full equipment has been manufactured and the machinery is now in process of erection at Cripple Creek.

THE CHICAGO RAIL BOND.

The consolidation of practically all of the street railway interests of San Francisco and the conclusion of the Market Street Railway Company thus formed to equip all lines so far as practicable with electric traction naturally led to the organization of an electro-technical department in the charge of men of undoubted experience and ability in electric railway construction. Of all the apparently "little" details of equipment that have come under the consideration of this department none have been given greater care and attention than that bestowed upon the all-important matter of rail-bonding.

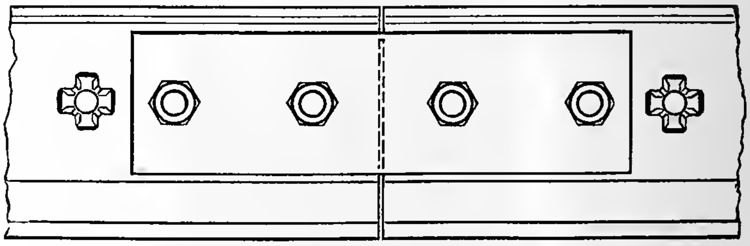


FIG. 1.—THE CHICAGO RAIL BOND.

In the earlier construction of electric railways the engineer made all his estimates and calculations with the utmost accuracy and scientific precision for the overhead half of the circuit, and spared neither money, time, labor nor copper to bring that half up to the highest standard of perfection; but the practical results which he aimed to attain, namely, a low percentage of loss or drop upon the line, and economical consumption of coal at the power house was seldom, if ever, realized, because he neglected to complete the metallic circuit by properly bonding the rails together at the joints. The energy losses occurring through defective bonding soon were realized to form an abnormally high factor in the total

losses in the operation of electric railways, to obviate which has been the study of the ablest electric railway engineers.

After mature consideration of all systems of rail-bonding yet devised, the Market Street Railway Company adopted the form shown diagramatically in the accompanying sketches and which is known as the "Chicago" rail bond. In this the rail bond proper, C, is a copper rod or wire having tubular or thimble-shaped terminals which are bent at right angles to the bond, and with its two tubular terminals is composed of one solid piece of rolled copper. The tubular or thimble-shaped terminals, A, are inserted into holes through the web of the rail, a, and the slitted end of the terminal, A, is spread or clinched over on the rail with a hammer and

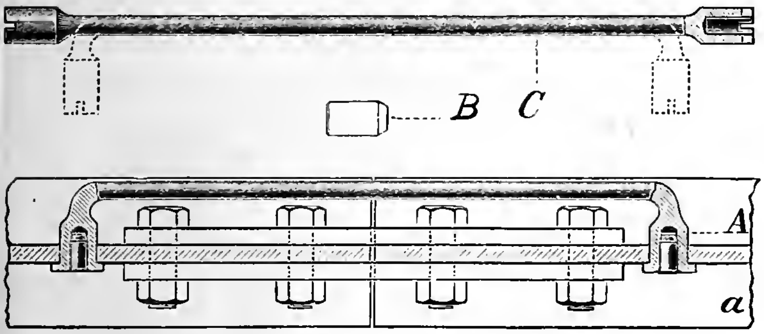


FIG. 2.—CHICAGO RAIL BOND.

punch; this holds it from drawing back out of the hole. The drift pin, B, which is larger than the opening in the tubular or thimble-shaped terminal, A, is then driven into said terminal, thus expauding it and wedging it into solid contact with the surface of said hole through the web of the rail, a, making an absolutely solid joint from which every particle of air and moisture is excluded and which experience has thus far shown to be proof against corrosion or electrolysis. The "Chicago" rail bond has therefore been adopted as standard by the Market Street Railway Company and is used exclusively in its lines in San Francisco.

SCIENTIFICALLY CUT LAMP GLOBES.

An invention that undoubtedly will be developed into great utility and that among many other applications, would seem to hasten the adoption of small arc lamps for interior or even desk use, is decribed in the London Journal in an article on "Holophane Globes," which is the name applied to glass globes that are cut on scientific principles for the proper dissemination of light. It is stated that holophane globes, when inclosing any light of high candle power, such as the Welsbach incandescent gas, or the electric lamp, give the appearance of a vase filled with light, brilliant, yet soft while the actual burner or filament cannot be discerned.

The principle of the holophane globe is readily explained. The interior surface of the globe is formed into vertical grooves, which are so shaped as to spread out horizontally the rays proceeding from every part of the light source. The mouldings on the outer surface of the globe are horizontal, and have the effect of distributing the emergent rays in the vertical sense; and inasmuch as the light may be required in some instances to be cast downward and in others to be equally dispersed, the angles of the outside grooves are modified accordingly. This is a very different thing from the unscientific cutting seen in ornamental cut glass globes which do nothing for the diffusion of the light.

As for the loss entailed by the reflection and refraction of holophane globes, it is certified by M. de Nashville to amount in the case of an arc light to from nine to thirteen per cent and as this observer remarks, there is no other kind of globe in existence capable of realizing such diffusion of light and presenting such uniformity of effect. As the loss of light by transmission through clear glass is from eight to ten per cent, the claim that holophone globes do their special work for about four per cent of loss, is well established.

It is pointed out in the Engineering Magazine that the invention of these globes may come in with acetylene lighting now in its very beginnings.

THE LAY PRESS.

POPULAR REFLECTIONS OF THE CONDITION AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

A new kind of "hustler" has arisen, and within the past three or four months he has been rapidly multiplying and filling the earth. He is the promoter of new electrical enterprises, and especially the promoter of schemes for the long-distance transmission of electric power. The air of the whole Pacific Coast has all at once become filled with talk about setting up water wheels in lonely mountain places and making them give light and cheaply turn other wheels in towns miles away. From Shasta to San Diego men are organizing, or trying to organize, local or San Francisco companies to utilize in this way the water power in particular localities. A few of these power-transmission enterprises have been successfully organized by business men of capital and the work of establishing them has been actually begun. The rest are yet in the air, and many of them will remain there for a long time.

But the interesting fact is that the State is full of "inquiry" in this direction, and consulting electrical engineers and agents of manufacturers are kept busy answering questions in person and by letter and making preliminary estimates of cost. Their business field is now very active and competition is keen and increasing. Big and little companies have agents here who are after every rumor of a new railway, light, power or other plant, and they keep to themselves every pointer they get to avoid sending a lot of competitors after their customers. Local manufacturing establishments are rapidly going into the manufacture of electrical machinery.

While the actual business done is mainly with new railway and lighting plants and new buildings, the activity over power transmission is the most interesting, if not the most important thing to the general public. The transmission of electric power has just entered upon its second stage. For years it has remained in the stage of theory and experiment.

Great public interest has always been taken in the prophesies of electrical engineers that the vast amount of power running waste in hills and mountains everywhere would be cheaply utilized by transforming it into electrical energy and taking it long distances to where it would be practicable to use it. In this State it has long been a popular and somewhat inspiring idea that the power in the streams and reservoirs of the Sierras would light the towns of the valleys and foothills, and so cheapen power in them that industries would be stimulated. The success of the experiments at Portland, Redlands, the Bodie mines and a few other places, where from twelve to twenty-five miles have been covered, has warranted the various new enterprises which contemplate providing power and light to towns in the Sacramento and San Joaquin valleys and in the foothills. So they have suddenly sprung up in numbers and the stage of practical business has just been fairly entered.

Sacramento is to be the first town to get river power from a distance on a large scale. The big plant near Folsom is to be ready for operation in four or five weeks, and then 5,000 horse-power will be kept pumping into Sacramento over twenty miles away to run the trolley lines and give light and power. The new company is invading the field of the gas company in the light business, and lively competition is promised.

The South Yuba Water Company is getting ready to do big and interesting things in Placer County. It controls an immense water system in Placer and Nevada counties, and has practically unlimited power at its command, and it can be utilized cheaply at high heads The company expects to have in operation by August 1st a plant that will light Newcastle, Penryn and Loomis. It will begin with 150 horse-power and $25,000 plant, with water used at 460 feet pressure. The company is said to plan invading Sacramento, twenty-two miles from Rocklin, with light and

power, and a scheme to operate an electric road from Marysville to Newcastle, along the foothills, is being much talked about.

Another enterprise that has passed the stage of talk is one to supply power to the big groups of mines about the region of Grass Valley and Nevada City. This company, which is composed of miners, proposes to sell power to mines for miles around at $75 per horse-power per year. Heretofore the power used at the mines has been mainly water power, sold by water companies at from $125 to $150 per horse-power.

It is in the mining regions that the use of electric power will naturally be most rapidly developed, and many mining companies are now figuring on establishing plants for their individual use.

One of the most interesting schemes that have been launched is that of the San Joaquin Power Company, which is perfecting plans to bring light and power into Fresno from one of the forks of the San Joaquin River, forty-three miles northeast of Fresno. This company is composed of Fresno capitalists. A San Francisco company has arranged to supply electricity to Bakersfield from a plant in Kern River Canyon, several miles from the city.

These are the only new enterprises in this line which are regarded as having passed the stage of talk. Several are in the air of Southern California, and a half-dozen schemes to electrify Stockton from the Sierras have come to the front since the railroad boom began.—San Francisco Call, June 1, 1895.

The widespread interest that is being taken in plans for the electric transmission of power gives promise that the great need of Californian manufacture is likely to be met within a few years. Capitalists and promoters are actively inquiring into the cost of plants, and the water powers are being grabbed or bought up as rapidly as they can be found. The great need of Californian manufacturers is cheap power. With the nearest abundant supply of coal 600 miles away and with much of the fuel shipped from England and Australia, it is impossible to compete in those lines of manufacture in which power is one of the largest parts of the cost.

But California has abundance of water power within her borders. The rivers and streams that take their rise in the Sierra Nevadas could furnish energy enough to run all the engines in the United States if only it could be harnessed and brought where it can be used. There is now no difficulty in harnessing the power of mountain streams, as electric transmission has reached a stage of progress in which power can be carried many miles with slight loss. The time is not far in the future, if it has not already come, when San Francisco will have the benefit of the power that has been going to waste in the mountains. The energy cannot be brought from the Sierras yet, on a commercial basis at least, but there is good authority for the statement that thousands of horse-power may be brought from Clear Lake and delivered to San Francisco manufacturers at a rate that will drive steam and coal from most of our industries.

The day is undoubtedly coming when the Sierra water powers can be brought to San Francisco, and when that day comes the city will have an unlimited supply of energy at its command. The rapid slopes of the streams that make a descent of three or four thousand feet in a short distance offer a chance to use the same water over and over. The capitalists have awakened to the opportunity. California should lead, rather than follow, in electrical transmission of power. There is both the supply of power and the absence of competition from the fuel supplies that worry the electrical companies elsewhere.—San Francisco Examiner. June 3, 1895.

A dispatch from Fresno says that the owners of the new water and electric plant being put in on the San Joaquin River have offered to furnish power for machine shops of the Valley Railroad, if built in Fresno, at one-half the cost of steam power.

It seems to be an irresistible conclusion that the greater part of the power which can be made available for industrial purposes in California must come directly from the forces of nature. We have no cheap coal in California, or, at least, none has been found as yet, unless we except the Livermore lignite, which has not been fully developed, and imported coal for manufacturing purposes is almost an impossibility, not on account of the forty cents a ton duty, but because of the cost of transportation. But in the mountains of California, from one end of the State to the other, there are rivers, streams and creeks which may be made a source of supply for power almost infinite. To convert the dynamic force of running water into electrical energy is one of the simplest of modern scientific problems, and the only practical difficulty is the economical transmission of the electric force over long distances.—San Francisco Chronicle, May 17, 1895.

The scheme for transmitting power from the north fork of the San Joaquin River to Fresno has been in contemplation, in one form or another, for a long time, but the work went forward so quietly that the public did not learn that any actual steps had been taken until operations had begun. Work has now been going on for some weeks on the canal by which water will be fed from the north fork to the reservoir, a distance of six miles, following the line of canal. * * * * *
It is not too much to say that a new era has dawned for Fresno and the surrounding country. The drawback heretofore has been that fuel was so expensive that manufacturing was at a disadvantage, especially where much power was used. This is now to be reversed. Power will be cheap, permanent and convenient, and coal will be known in Fresno no more, except, perhaps, in a few cases where electricity cannot be made to answer the purpose, which will mark the dawn of a day such as the San Joaquin Valley has never seen.—Fresno (Cal.) Republican, May 12, 1895.

News of the Month.

TELEPHONE AND TELEGRAPH.

Riverside, Cal.—H. H. Streeter has been granted a telephone franchise.

Napa, Cal.—L. Grothwell, of San Francisco, has applied for a franchise for the erection of telephone and telegraph lines from Napa to Calistoga.

Great Falls, Mont.—Rapid progress is being made in the construction of the new telephone line from Great Falls to Lewistown, a distance of fifty-three miles.

Sacramento, Cal.—The Board of Supervisors have posted notice of sale on June 24th of a franchise for the construction, operation and maintenance of a telephone and telegraph system in Sacramento County. Evidences of having secured at least 400 bona fide telephone subscribers must be presented.

MISCELLANEOUS.

Portland, Or.—A school for electricity has been established under the direction of Professor Loverage.

Sacramento, Cal.—The Electro-Chemical Amalgamating Co. has been incorporated. Calvin Brown is one of the Directors.

Los Angeles, Cal.—The Dheuy Oil Company does its oil pumping by electricity, using the Commercial Electric Company's motors.

Sprague, Wash.—Lightning entered the station of the Sprague Electric Light Works on May 18th, doing damage that necessitated a week's shut down.

Oregon City, Or.—F. E. Ball of the Electrical Reduction Works has gone to Southern Oregon to exploit his electrical method of reducing refractory ores. His assistant, E. F. Kennedy, accompanies him.

San Jose, Cal.—The Electrical Improvement Company has paid Giovanni Giraudi $2,000 as judgment and $774 as interest and costs for the loss of his right hand by an injury received from contact with an electric light wire on the roof of a house at night in a storm.

La Center, Wash.—A Clark County lumberman has erected a plant consisting of an electric motor driving a drag saw. With this equipment it requires but three minutes for the saw to cut through a five foot log, and the saw cuts on an average 100 cords of wood a day.

San Francisco, Cal.—Neil Cameron, a lineman of the Fire Alarm system, has brought suit against the W. U. T. Co. and the city to recover $20,000 damages for personal injuries, alleged to have been caused by the falling of a telegraph pole upon which he was working.

San Francisco.—The Municipal Signal Company, of Boston, has served notice on the Board of Supervisors that the city will be held responsible for its use of the police signal system in service, alleged to be an infringement of patents owned by the company named.

Berkeley, Cal.—Suit has been entered by C. W. McLaughlin against the Western Union Telegraph Company for damages in the sum of $5,250, for failure to deliver a message owing to a mistake made by an employee in making the name "Dietz" appear as "Dieth."

Tacoma, Wash.—Electricians Bochelet and Fraser have entered into a contract with the Northern Pacific Railway Company to recover a safe that was lost in the bay during a recent landslide and which cannot be found. The electricians propose to locate the safe by electro-magnetic means.

Portland, Or.—The General Electric Company has brought suit against the receiver of the Oregon Railway and Navigation Company to recover damages in the sum of $63,916.43 for the loss

of electrical machinery by fire on September 23d last, such machinery being consigned to the Portland General Electric Company.

SAN FRANCISCO.—Suit has been entered by C. C. Terrill and the German Savings and Loan Society against Fabian and Margaretha Joost, to foreclose two mortgages aggregating $141,000, which sum represents money borrowed to assist the San Francisco and San Mateo Electric Railway out of its financial difficulties some time ago.

TRANSMISSION.

PERRIS, CAL.—It is possible that the San Antonio Light and Power Company will extend its 10,000-volt circuit to this city.

VISALIA, CAL.—Satisfactory progress is being made in the negotiations for the transmission of electric power from the Kaweah River to this city.

PHŒNIX, ARIZ.—The great Walnut Grove dam may be rebuilt, and if so an electric power plant of considerable magnitude will be installed.

SAN DIEGO, CAL.—An electrical engineer is figuring on a plant to supply this city with electric power from a waterfall on the flume line of the San Diego Flume Company.

SILVERTON, COL.—The 150 h. p. general electric generator and Pelton wheel installed in the Silver Lake mines last August by E. G. Stoyber, has been supplemented by a duplicate equipment.

SAN JOSE DE COSTA RICA.—Considerable electric work is being installed in this vicinity, one of the latest orders being for a 150 h. p. General Electric generator with Pelton wheels, for this city.

FALL RIVER MILLS, CAL.—A company represented by a Mr. Gale expects to put in an electric plant at the falls and irrigate the plains between Fall City and Burgettville, an area of 15,000 acres.

SALMON CITY, IDAHO.—The Gold Dredging Company has installed a 150 h. p. Pelton water wheel and a 100-kilowatt General Electric generator. These are direct connected and used in general mining work.

SPOKANE, WASH.—A warranty deed has been filed conveying from the Spokane Falls Water Power Company to the Northwest Milling and Power Company all its title to the water power of the Spokane Falls in consideration of $400,000.

PROVO, UTAH.—A large party of engineers and laborers, in charge of F. J. Kramer, have commenced work on the Provo power transmission plant in Provo Canyon. This enterprise is under the financial management of L. L. Nunn, of Telluride, Colorado.

SAN JOSE, CAL.—Charles Franklin, of San Francisco, owner of a valuable water right in the Sauta Cruz Mountains, twelve miles from this city, is considering electrical transmission therefrom to San Jose. The stream is said to be capable of generating 10,000 h. p.

QUEZALTENANGO, GUATEMALA.—The Pacific Mail steamship Colima, recently wrecked off the west coast of Mexico, contained a shipment of Pelton water wheels that were to have displaced the turbines in use in the central station in this city. The order has been duplicated.

HIDALGO, MEXICO.—The Cia. Anonima de Transmission Electrica de Potencia has installed a 2,000 h. p. mining transmission plant, consisting of five 3-phase General Electric generators direct coupled to Pelton water wheels running under an 800-foot head. The transmission is of 10,500 volts.

SALT LAKE CITY, UTAH.—Indications point to a very spirited rivalry between the two Big Cottonwood enterprises. Each expects to place 3,000 h. p. of electric power upon the Salt Lake City market before the year is ended. These companies are the Utah Power Company and the Big Cottonwood Power Company.

TRANSPORTATION.

NAPA, CAL.—A company is being organized for building an electric road to Calistoga.

ONTARIO, CAL.—The power house for the new ntario street railway is about completed.

REDLANDS, CAL.—An electric railway to Hemet via Moreno and San Jacinto is being considered.

SAN FRANCISCO, CAL.—The Board of Supervisors is considering plans and models of car guards or fenders.

VISALIA, CAL.—The talk of building an electric road from Merced into the Yosemite Valley is being revived.

PETALUMA, CAL.—The construction of an electric railroad between this city and Santa Rosa is believed to be a certainty.

SANTA MARIA, CAL.—Messrs. W. T. Lucas et al. have applied to the County Supervisors for an electric railway franchise.

PORTLAND, OR.—The City and Suburban Railway Company is operating a large trolley street-sprinkler with great satisfaction.

PASADENA, CAL—The new line of the Pasadena and Los Angeles Electric Railway Co. was formally opened for business on May 6th.

SAN RAFAEL, CAL.—The newspapers favor the construction of an electric road to run from San Rafael to Ross Valley and Point San Pedro.

NAPA, CAL.—It is stated that Eastern parties are about to apply for an electric railway franchise extending from Napa into Lake County.

HAYWARDS, CAL.—Messrs. Chisholm & Petermann have been granted a franchise for an electric road from Haywards to Mount Eden and Alvarado.

SACRAMENTO, CAL.—The Central Electric Railway Company is erecting a toboggan slide in East Park to cost $4,000. It will be run by electricity.

LOMPOC, CAL.—Dr. Lucas et al. has applied for a 50-year franchise for an electric road to run from Wigington, through Santa Maria to the ocean.

BERKELEY, CAL.—The horse-car track on University avenue, between East and West Berkeley, is being bonded, and cars have been ordered preparatory to changing to an electric equipment.

LOS ANGELES, CAL.—The boilers and the foundations for the engines and generators of the Los Angeles Traction Co. are being erected and are expected to be in operation by the 1st of July.

PASADENA, CAL.—Work is progressing steadily on the new electric railway forming the extension of Professor Lowe's mountain railway, and it is expected that the line will be completed to Crystal Springs by July 1st.

STOCKTON, CAL.—H. T. Compton, Consulting Engineer of the Lodi Electric Railway, states that the preliminary survey has been finished from this city to Lodi. Plans will be ready for the contractors in a few days.

SANTA CRUZ, CAL.—A colored porter employed about the carhouse disregarded warnings and "fooled" with the equipment of a car which started the car on a run away up the street, smashing the car and tearing out the side of a house.

SANTA ROSA, CAL.—Leading business men are considering the feasibility of connecting the valleys of Napa and Sonoma counties with an electric belt railway, having its terminus at tidewater, there to connect by fast ferry service with San Francisco.

SAN FRANCISCO.—The Market-street Railway Company is improving the Bryant-street power house by the addition of four 1,200 h. p. triple expansion engines, and direct connected Siemens-Halske generators with necessary boilers, etc. The engines are now being constructed by the Union Iron Works, and when completed the plant will supply power for the operation of the Mission, Folsom, Bryant, Sixteenth, Kentucky, Third and Kearny streets systems.

MARYSVILLE, CAL.—Work has been commenced on the electric road to be built from Marysville eastward through the foothills of Yuba and Madera counties and southeast to Auburn. It will cover nearly fifty miles of track, and when complete it will be the longest line of electric road west of Chicago. The purpose is to afford the orchardists and farmers in the foothills easier facilities for getting their produce to market and at a lower cost. Passengers will be carried, as well as freight, and power will be supplied by the South Yuba Water Co.

PORTLAND, OR.—A party of Scotch capitalists accompanied by their own engineer, proposes to purchase the street railway system of Salem and to bond it for $200,000. It is also announced that this party is negotiating the consolidation of the entire street railway service of Portland excepting the cable road to Portland Heights. This consolidation involves an investment of $3,000-000 and will take in 115 miles of street railway tracks owned by the East Side Company, running from Portland to Oregon City with lateral lines at several points, the Portland Consolidated Street Railway company and the City and Suburban Street Railway company with lines traversing the city in all directions.

SAN FRANCISCO.—The electric trolley road now being built on Fillmore street will encounter a grade of 25.5 per cent. between Green and Vallejo streets, and a grade of 24 per cent. between Vallejo and Broadway, to overcome which the Market-street Railway Company proposes to place an underground cable under each track; this cable running over sheaves at the top and bottom of the hill. The cable will be run around the sheaves after the manner of an ordinary cable road, and will be operated by an electric motor geared to the sheave at the top of the hill. No ordinary form of grip will be provided on the cars, but instead a special grip will be hooked on to the car, securing it rigidly to the cable.

RIVERSIDE, CAL.—Professor Baldwin, President of the San Antonio Light and Power Company, of Pomona, in a recent lecture, named Mill Creek, Lytle Creek and the Santa Ana and San Jacinto rivers as among the best streams to be relied upon to furnish power the year round in this portion of Southern California. Electric power could be delivered in Riverside from the San Jacinto at a cost of $125,000 for 300 h. p., and he advised the City Trustees to change their call from $40,000, to be voted for a municipal lighting plant, to $125,000.

NEW WESTMINSTER, B. C.—F. S. Barnard, M. P., manager of the Consolidated Railway and Light Company, proposes to develop the water power of Seymour Creek at a cost of $200,000, in the event of a bonus of $50,000 from the city and the acceptance of a proposal to light the city at 25 per cent. less than the present cost, the bonus named to be used in the construction of a railroad from Sapperton to Stevenson. The project contemplates the delivery of 1,000 h. p.

SACRAMENTO, CAL.—The contract between the Central Electric R ilway Company and the Capital Gas Company, by which the latter furnishes electric power for street railway purposes, expires on June 30th, by which time the electric transmission from Folsom must be in operation. Superintendent T. A. W. Shock, of the Sacramento Power and Light Company, states that the Folsom transmission will be started by June 24th, when the first equipment of 1,000 h. p. will be in operation. Of this 300 h. p. will be required by the railway and the balance will be for sale. In all 280 men are now employed on the work. A movement is on foot to celebrate the completion of the Folsom transmission by an electric carnival, to be held during the State Fair.

GRASS VALLEY, CAL.—Contracts have been awarded by the Nevada County Electric Power Company to the Stanley Electric Manufacturing Company, through Martin & Lindner, for two 300-kilowatt Stanley two-phase generators, and to the Pelton Water Wheel Company for two Pelton wheels to drive the same. The plant will be located on the South Yuba River, where 2,500 h. p. can be developed with comparative ease, driving the wheels under a head of 250 feet. The transmission circuit will run direct to Nevada City, whence a loop circuit will be continued for a distance of nine miles from the power-house, embracing Grass Valley and seven groups of mines. The contracts just awarded are for the initial installation.

FRESNO, CAL.—A gang of men is at work on the canal to furnish water from the North Fork of the San Joaquin River to the power house for the Fresno transmission. An impounding reservoir, to contain 3,500,000 cubic feet of water, and which amount can easily be doubled, will be readily constructed by throwing up a low embankment. The pipe line to the power house will be 4,000 feet long, delivering water at a head of 1,410 feet. Pelton wheels, each having a capacity of 400 h. p., are to be used, and it is proposed that the generators will deliver current at 550 volts, which will be raised to 11,000 volts for transmission and delivered in Fresno, a distrnce of 33 miles, at a loss of 10 per cent. The initial plant will have a capacity of 1,000 h. p. The corporation is backed with Chicago capital.

LIGHTING.

TINTIC, UTAH.—The new electric light plant has been started.

LEWISTON, IDAHO.—W. A. Smith has applied for an electric light franchise.

ARCATA, CAL.—The new arc and incandescent plant will soon be in operation.

CHICO, CAL.—Bids for an electric light franchise will shortly be advertised for.

VERNON, B. C.—The question of a municipal electric lighting plant is again agitated.

COLTON, CAL.—The question of a municipal electric lighting plant is being agitated.

HAILEY, IDAHO.—The electric light plant has been leased to John Hart for one year.

KAMLOOPS, B. C.—An electric lighting plant is to be placed in the Slocan Star mine.

ASTORIA, OR.—The river steamer Telephone is having an electric light plant installed.

ALAMEDA, CAL.—The city has concluded to furnish incandescent service at meter rates.

BUTTE, MONT.—The electric light company is constructing a 40- by 120-foot addition to its plant.

BODIE, CAL.—Part of the Three Mile Post mine on the Hawthorne Road is lighted by electricity.

VENTURA, CAL.—The Board of Trustees has approved of specifications for an electric lighting plant.

MISSOULA, MONT.—The electric light company will soon begin work on a new power dam to cost $100,000.

SONORA, CAL.—An electric lighting plant is to be placed in the Miller & Holmes mine at Quartz Mountain.

CHICO, CAL.—The public are demanding the installation of an electric lighting plant by the local gas company.

NEW WESTMINSTER, B. C.—A proposition is on foot for the sale of the municipal lighting plant and water works.

BOULDER, MONTANA.—Frank Bernatz is considering a plan for the erection of water works and an electric lighting plant.

VICTORIA, B C.—The municipal lighting plant has been increased by the addition of two 60-light Wood arc dynamos.

FLORENCE, COL.—The new cyanide mill of the Metallic Extraction Company has installed an 8½-kilowatt incandescent plant.

SPOKANE, WASH.—The new Court House is to have an electric lighting plant. Address A. L. Thorp, Chairman, Spokane, Wash.

PASADENA, CAL.—The Pasadena Electric Light & Power Co. is installing a new 250-horse-power engine, and a 1200-light alternator.

VICTORIA, B. C.—M. Hutchinson has been elected general superintendent and chief engineer of the Municipal Electric Light Works.

SALT LAKE CITY, UTAH.—The Citizens Electric Co. has purchased a site for its power house, and is rapidly pushing work on its new plant.

OROVILLE, CAL.—A franchise for an electric lighting plant in the towns of Gridley and Biggs has been sold to T. C. Blair and L. H. Williams.

SAN BERNARDINO, CAL.—An electric lighting plant and a 20 h. p. electric motor, is to be placed in the Southern California State Asylum.

SEATTLE, WASH.—The Seattle Electric & Gas Fixture Co. have obtained the contract for the electric lighting plant of the new State University.

HELENA, MONT.—H C. Sterling has been appointed Superintendent of the Helena Power and Light Company, vice J. A. Tupper, resigned.

HELENA, MONT.—The Capital Lighting Company having secured the city contract, will send Manager J. A. Tupper East for additional equipment shortly.

RIVERSIDE, CAL.—The special election recently called, voted to incur an indebtedness of $40,000 for the construction of a municipal electric lighting plant.

CRIPPLE CREEK, COL.—The Gold and Silver Extraction Company of America (Limited) has placed a 6-kilowatt Edison dynamo and incandescent plant in its new cyanide mill.

SAN MATEO, CAL.—The San Mateo Electric Light Company, recently incorporated by F. M. and F. A. Greenwood et al., has applied for a franchise to erect pole lines for lighting the city.

MILL VALLEY, CAL.—The San Rafael Gas and Electric Light Company is stringing wires between San Rafael and Mill Valley, and will furnish incandescent service in Mill Valley early in July.

SAN FRANCISCO, CAL.—It is announced by J. B. Crockett, President of the San Francisco Gas Light Co., that that company is to erect an electric light and power plant, costing about $3,000,000.

SAN JOSE, CAL.—The San Jose Lighting Company has been incorporated with a capital stock of $250,000. The Directors are C. F. Wilcox, R. L. Slack, J. R. Patton, William Sumner and J. J. Southheimer.

AUBURN, CAL.—The Republican states that the South Yuba Co. will have its lighting service in operation in Newcastle, Penryn, Loomis and Rocklin by July 1st. It is to be a water power plant under a head of 483 feet.

BOISE CITY, IDAHO.—The people of the New Plymouth colony, Payette Valley, propose to construct a canal three miles long and build an electric plant for lighting the village. Wm. E. Smythe is the father of the colony.

LOS ANGELES, CAL.—Bids were received until June 20th for the furnishing of materials and labor for the erection of an electric lighting plant, to cost less than $10,000, at the Pacific National Home for D. V. S.

SALT LAKE CITY, UTAH.—An ordinance has been passed fixing the maximum height of the electric light poles at thirty feet, the lowest at twenty-three feet on paved streets, the maximum height at twenty-seven feet on unpaved streets.

OAKLAND, CAL.—The contract for lighting the city by gas and electricity for the fiscal year ending June 30, 1896, has been awarded the Oakland Gas Light and Heat Company, which voluntarily made a reduction of $5,000 in the contract price.

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Steep Gradients on Electric Roads.

BY LIEUT. W. STUART-SMITH, U. S. N.

Some years after the completion of the Richmond Electric Road, and when facts had demonstrated that electric traction was an assured success, Mr. Frank J. Sprague gave an account of some of his experiences showing the difficulties to be overcome. Among other things to be surmounted was a grade of 10 per cent., and so great did the undertaking seem that Mr. Sprague and his engineers were fearful of possible failure until the trial car actually began to mount upward. Just before reaching the foot of the grade there was a general expression of fear as to the result of the attempt, the only confident member of the party being a machinist, who was willing to risk his hard-earned dollars that the car would go up. As the grade was reached and the car started smoothly upward the hearts within it beat joyfully, but soon unpleasant sounds and bad smells came from beneath the car and the joy was not unalloyed. The top was reached and the fact demonstrated that a self-propelled car would go up a 10 per cent. grade; also that the 5 h. p. equipments with which the car was provided were far too small.

Mr. Sprague remarked to Mr. S. Dana Greene that some instruments were needed, and these were presently brought—four strong mules. With stronger motor equipments the "instruments" became unnecessary, and as improvements were made steeper grades were overcome until hills nearly ceased to be a terror to street railway engineers. At present, with the powerful equipments provided, grades having nearly the greatest theoretical possible rise up which self-propelled vehicles can go are undertaken. In many places, however, notably in San Francisco, the grades are so great as to be beyond the power of any car depending upon the friction between wheels and track to surmount. As such grades are generally short—one to three blocks—a simple and successful method by which self-propelled cars could mount them would permit the extending of electric traction to all parts of the city, and a description of some of the plans in operation and proposed may not be uninteresting.

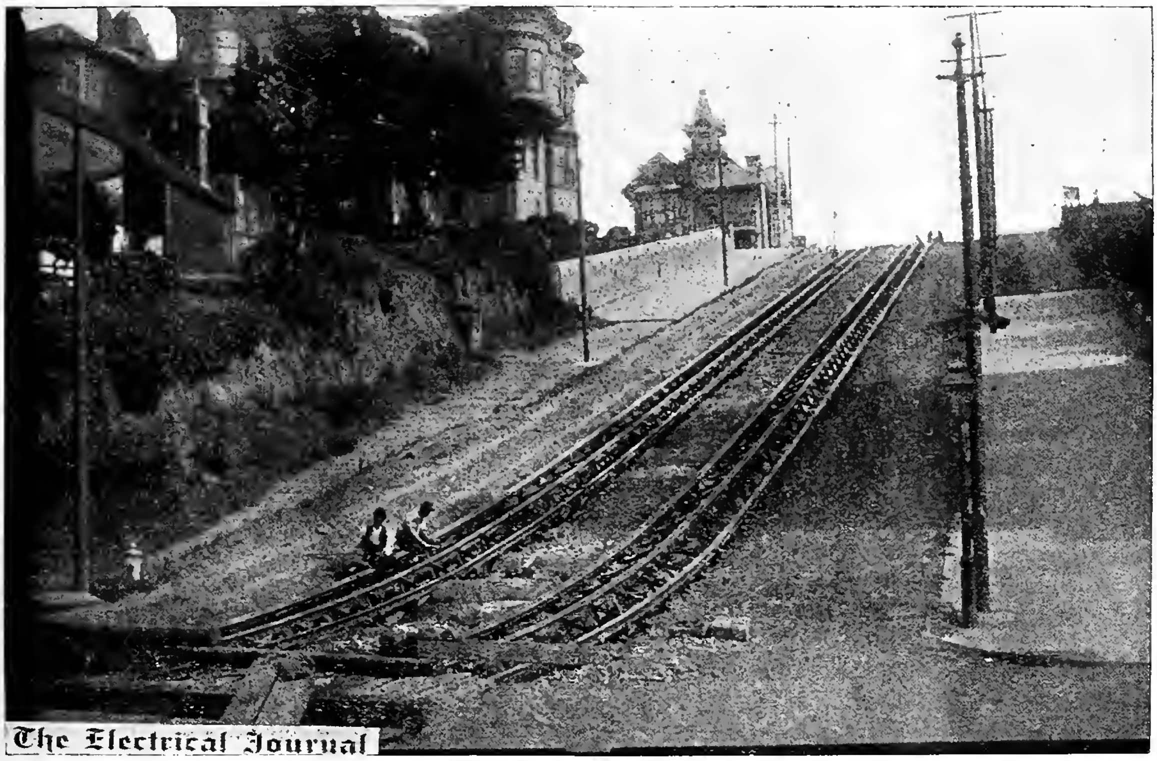


FIG. 5.—THE FILLMORE STREET GRADE IN SAN FRANCISCO—25½ PER CENT.

One of the first attempts to overcome excessive grades was made in 1887 by Mr. Leo Daft, in Pittsburg,

Pa. The grade was about 16 per cent., and with the equipments then in use could not be overcome by direct traction. The old style Daft locomotive was used to haul trailers. The heavy motor was carried inside the locomotive and geared to the axle by a sprocket chain. A small shaft carried in a pivoted framework was also driven by a chain. This shaft carried a sprocket wheel, the projections of which entered holes in an iron plate which was laid between the rails on the grade. When running on the level the movement of a lever raised the sprocket wheel clear of the road and on the grade being reached it was lowered, and, gearing with the perforated plate, assisted the car up the hill. It was used for a few months only. Various other methods of assisting a car up grades by the use of rack and pinion have been proposed, but for ordinary street service none of them have come into permanent use.

On the line of the San Francisco and San Mateo road, in San Francisco, there is a grade of nearly 18 per cent. on Harrison street, between Second and Third, down which cars go on the uptown line. No attempt is made to climb this grade, it being overcome in two stages on another street. When the road was first built it was considered dangerous to descend this grade without some retarding force other than that carried by the car, and a weight was lowered from the bridge at the Second street cut. As the car descended it raised this counterweight to the top by means of a rope, and the work thus done made it impossible for the car to run away. After the car reached the foot of the grade the counterweight was lowered to the bottom by means of a drum, and was ready to assist the next car. The arrangement was a bother, and after the motormen became more skilled in handling the car it was discarded and the descent made on wheel brakes alone, with the assistance of plenty of sand.

An arrangement patented by a Mr. Kuhlmann has been in successful operation for the past three years on a single track road in Seattle, Wash. The operation is made clear by the accompanying illustrations. In Fig. 1, A is the main car track and B an auxiliary track in a subway which extends the length of the grade. Near one of the main rails is a conduit slot, D. At the top and bottom of the grade are sheaves, around which passes a rope, the ends of which are made fast to a car carrying slabs of lead, O. O, the total weight of which is seven tons. Buffers (E. E.) having air cushions are provided at the top and bottom to arrest the motion of the counterweight car. Figs. 2, 3 and 4 show plan and elevation of the coupling by means of which the car is connected to the rope. Its position on the rope is shown at H, Fig. 1. The link M, secured to the rope as shown, carries the pivoted piece K, the head H, of which projects above the slot, as in Fig. 3. The drawbar I is permanently carried by the car, and when desired it is coupled to H by means of the loose pin J.

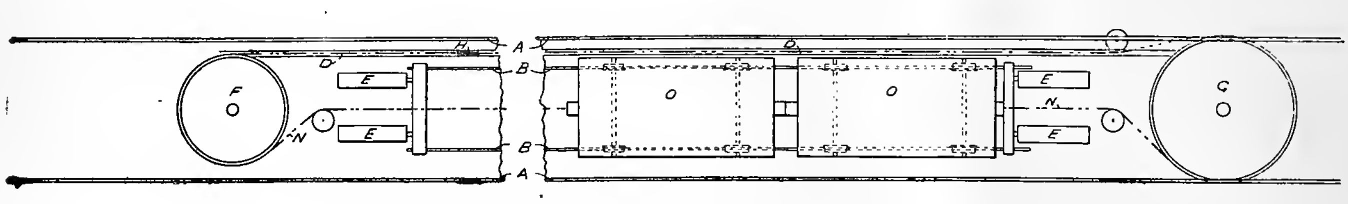


Fig. 1.—Steep Gradients on Electric Roads. The Seattle Counter Weight.

The operation is as follows: The road is single track and is used by cars going in both directions. Suppose the counterweight is at the foot of the grade and a car is starting to go down. The drawbar is coupled to the brake and the descending car pulls the counterweight to the top, where it passes over a slight reverse grade to prevent its running back. The next car coming up grade finds the coupling at the foot, and after making connection uses its motors to pull the weighted car over the slight reverse grade when the descending weight assists the car in mounting. This grade is but 16 per cent., and under such conditions as exist in San Francisco, and with modern equipments, would no doubt be taken without any outside assistance, but the cars in Seattle are equipped with the old style of F 15 double reduction motors which are not powerful enough for that grade, and moreover the track in winter is very slippery with ice and snow. The same arrangement was installed in Portland, Or., and Providence, R. I., but the writer does not know whether they are now in use.

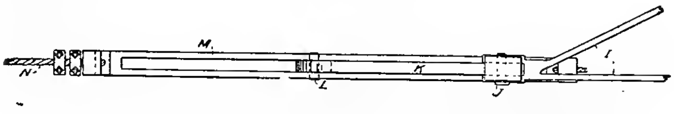


Fig. 2.—Steep Gradients on Electric Roads.

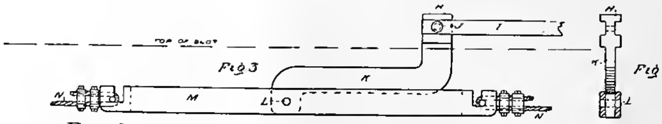


Fig. 3 and 4.—Steep Gradients on Electric Roads.

San Francisco is pre-eminently a city of heavy grades, the overcoming of which was the incentive which led to the development of the cable system for street-cars. Up to a year ago there were but two elec-

tric roads in the city, the San Francisco and San Mateo and the Metropolitan. When the Market-street Company obtained possession of nearly all the street-car lines in the city it turned its attention to electricity as a motive power and the success of the first road, the Mission-street line, was so marked that the work of electrically equipping other roads was rapidly pushed until at this present writing the Company has many miles

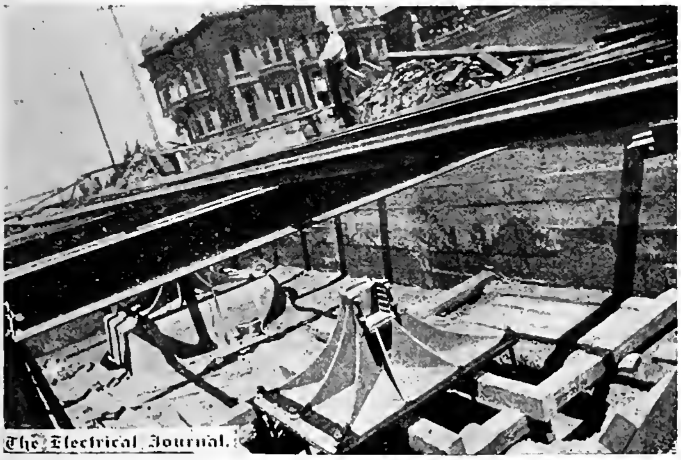


Fig. 6.— Steep Gradients on Electric Roads.

in operation and many more under construction. The first roads equipped were those having grades that could be easily surmounted, but when the cross-town line on Fillmore street was undertaken very heavy grades were encountered between Green street and Broadway. From Green to Vallejo street the grade is 25½ per cent., and from Vallejo street to Broadway it is 24 per cent. These were too heavy for direct traction, and plans were devised in the office of the Company's engineers which, will undoubtedly solve the problem of overcoming steep grades and permit the electrical equipping of all the cable lines. The views given show the condition of things at this writing.

The view (shown in Fig. 5) looking up grade is from Vallejo street toward Broadway, and shows an ordinary cable construction, the only difference being a guide 4″ x1″, which extends the length of the conduit at about half the depth of the conduit as in Figure 9. An endless rope will be used which passes around sheaves in pits at the top and bottom of the grade, the sheave at the bottom being carried in a cradle, by means of which stretch of the rope can be taken up. In the upper pits —a photograph of which showing the main pedestal is given in Fig. 6—are two sheaves, the forward one being an idler and the after one the main sheave. The cable coming from the conduit on one side passes around the main sheave, then forward around the idler, back to the main sheave, around which it makes a second turn, and thence to the other conduit. This gives so much hold as to prevent any possibility of slipping of the rope. The main sheave is provided with a brake, the lever of which is located so that a man can see the cars on grade and at once apply the brake in case the draw pennant connecting either car to the rope should give way and leave the other car free to run down hill.

At two points on the rope are clamped travelers which ride on the guides and prevent the rope being pulled upward into the slot. The position of these is such that when one is at the top of the grade on one track the other is at the bottom on the other track. The sketch presented in Fig. 8 shows the construction clearly, and it will be seen that it is impossible for them to get off the guidebar. They project a short distance above the slot and are provided with holes to which draw penants about ten feet long are shackled. Two short penants are secured to the car, one to the car body and one to the track, the duplicate arrangement being for safety only. The penants on car and cable carry halves of a coupling which are secured together by a pin which locks with a half turn. The coupling and uncoupling will be done by men stationed at the ends of the grade. Double crossovers are provided at both top and bottom of the grade, so that cars can pass from one track to the other. The necessity for this will readily be seen.

In Seattle, on the Union Trunk Line, a cable and electric line used the same track on a steep grade, and though the electric car could go up the grade alone, it was considered not altogether safe, especially in winter, and an attempt was made to obtain assistance by coupling to the cable dummy. The electric car was too heavy and the motors were used to take the strain, and trouble was at once experienced. The old style Edison controller was used, and it was impossible to obtain even an approximate agreement between the speed of the cable and that at which the electric car tended to run. The cable speed was so slow that the armature speed was forced down to a point where the current taken was more than it could stand, and after several severe burnouts the plan was abandoned.

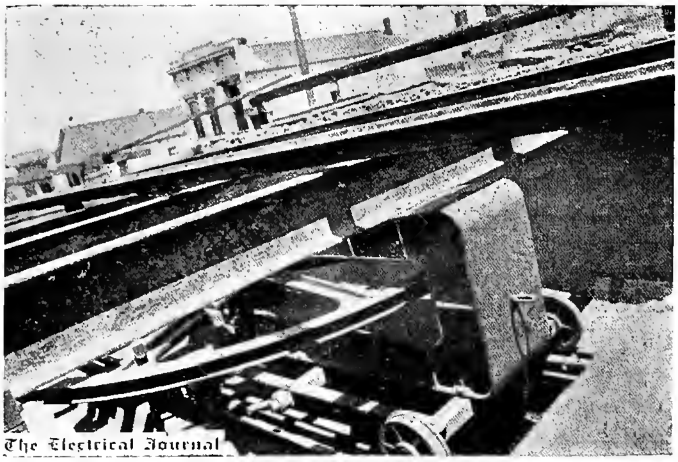


Fig. 7.—Steet Gradients on Electric Roads.

It is desired, if possible, in this Fillmore street installation, to make use of no other power than that which can be obtained from the car motors, the rope ordinarily being dead, and the first trials are to be made with this end in view, the operation being as follows: Suppose a car approaches the top of the grade and wishes to go down. It finds the traveler on that side and couples to it by means of the penants. At the same time a car at the bottom on the other track couples

to the traveler found there. Both cars will use their motors, the ascending one doing its best to climb the grade, and the descending one pulling on the cable, thereby assisting the one climbing up. The motor equipments on each car have a nominal rating of 50 h. p., with a capacity of 100 per cent. advance on this rating for short periods. Thus, the descending car is capable of exerting 100 h. p. on the rope, and as the two cars are balanced against each other, this power is available for overcoming the friction of the rope, sheaves, etc., and caring for a possible difference between the loads of the ascending and descending cars.

The engineers in charge of the work have so much doubt of the success of this plan of working, that the upper pit and the entire length of the conduit is to be left open until after a trial, in order that changes may be made in case of necessity. The change would be the installing of a stationary motor in the upper pit and

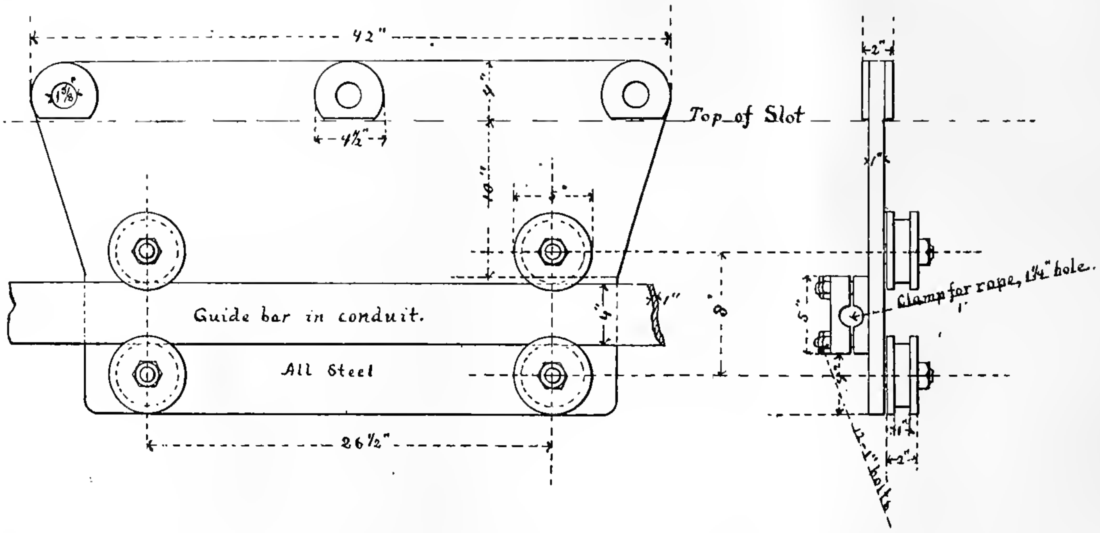


Fig. 8.—Steep Gradients on Electric Roads.

using it to drive the main sheave, and with it the rope, but in the opinion of the writer the plan as above outlined will be found to give perfect success.

The cars are not in a position to make use of the entire weight for traction purposes, but the component of the weight normal to the rail will probably be sufficient to prevent skidding of the wheels, in which case the entire power of the motors will be available, and the writer believes that in case it should be found impossible to use the motors of the ascending car, owing to difficulty in obtaining a balance between the electrical conditions of the two car equipments, the power of the descending car will be ample for hauling the other up grade. This confidence is based on the experience of the Kyoto Canal Company, Kyoto, Japan, the working of which the writer had under observation for two years.

The Kyoto Canal connects with Lake Biwa, and upon reaching the suburbs of Kyoto, it finds itself far above the level of the section running through the city. This difference of level is overcome by an incline railway 1,800 feet long, up and down which boats are hauled in cradles, one of which is attached to each end of a cable operated by a 50 h. p. Sprague motor. At the top of the main grade there is a short reverse grade, down which the cradle descends into the water to receive or discharge a boat. The motor is geared to a large drum by several reductions, the loss in which is necessarily considerable. When the motor starts and the cradles at both ends of the rope are being hauled out of the water and up the inclines the motor develops about 50 h. p., but as soon as the one at the top passes over the crest and the weight of the cradles and boats are balanced against each other the power falls to about 5 h. p., this being all that is required to haul 1,800 feet of rope and overcome loss in gearing, etc.

Reverting to the street railways, the power that may be required for moving the cars in an extreme case is easily shown. Suppose the car going down grade is empty and the one coming up is carrying 100 passengers, having an average weight of 120 pounds, or a total load of 12,000 pounds. If the speed is eight miles per hour the vertical rise on a 25 per cent. grade will be 176 feet per minute, which for the load of 12,000 pounds will require 64 horse power. This added to the 5 h. p. required to haul rope, etc., will make 69 h. p. required in an extreme case As there is available 100 h. p. on the descending car alone, it is evident that the power is ample.

Moreover, with the series-parallel controller and the much greater range of working than was possible in the above mentioned Seattle failure, there should be no difficulty in the ascending car using its motors. When the cars are coupled to the rope and the grade taken, for similar positions of the controller on the two cars the speeds will tend to be very different, and as they must have the same speed, owing to their connection with the rope, trouble may be experienced, but as the rope is not fixed in its speed, being controlled by the cars themselves, after some hunting the motors should settle down to a common speed. The wide range of working possible with the series-parallel controller will assist in this,

and after the motormen have had some experience, a balance should be quickly attained.

Considerable curiosity has been expressed as to the use of the double cross-over at top and bottom of the grade (Fig. 10). The *raison d'etre* is plain. The car coming up on the proper track will leave its traveler on the wrong side for the next car going down, and hence this car must cross over in order to couple to it, and similarly, the ascending car must cross over at the bottom in order to get the lower traveler. At top and bottom they must again cross to their proper track. Thus

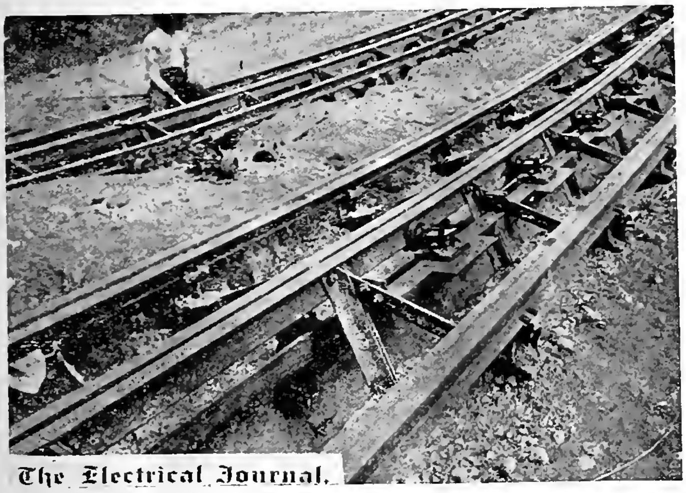


FIG. 9.—STEEP GRADIENTS ON ELECTRIC ROADS.

every other car going in either direction must cross over.

Another plan for climbing grades is the electric tractor, invented by a Mr. Van Zile. It is built on the principle of automatically controlling the traction between a middle rail called the traction rail and two drivers, which are toggled together at an angle in such a manner as to grip the traction rail between them. The amount of pressure is directly controlled by the tractive force required. As a middle rail somewhat raised above the street surface is required, this plan is hardly likely to be applied to street car service.

* * * * * * * *

On Monday, Aug. 5th, the plan above described was tested and found to work so successfully, as to be really monotonous. An old-time bobtail car was first lowered down, secured to the rope and used as a drag to assist in lowering the first heavy electric car. Two electric cars were then secured to the rope and tests made with the cars loaded in various ways. The car coming up grade with a considerable load made no use of its motors and was readily pulled up by the empty descending car with controller on second notch, showing, as the writer expected, that the power of one car is far more than necessary for hauling the ascending car under any possible condition of load, and settling once for all the question as to whether it would be necessary to install a stationary motor in the pit. Previous to the tests, the writer was informed that the consulting electrician of the company, Mr. S. L. Foster, doubted the success of the plan, but during the tests he said there was at no time any doubt in his mind, as from the beginning he was confident of success. There were many doubting Thomases, but he was not one of them.

The system was under hard test daily until Saturday, July 10, when the regular service on the Fillmore street line was extended to the bay, covering the grades here described and the scheme is now working to perfect satisfaction.

The Market Street Company is to be congratulated upon having found a simple and successful solution to a difficult problem.

STATICAL ELECTRICITY IN HISTORY.

San Francisco Council, No. 1, of the National Convention of Stationary Engineers, has engaged the services of Mr. M. A. de Lew, E. E., M. E., LL. B., to deliver three lectures on electricity. The first was given on Thursday, Aug. 1st. His subject was "Statical Electricity." In the course of his remarks he spoke of some of the popular delusions. He contended that Dr. Benjamin Franklin was not the first to discover atmospheric electricity. He gave the discovery to the people who named the Pyramids, stating that they noticed a blueish flame at the tops—hence the name, which means fire-mounds. His next allusion was to Flavius Joseph, known as Josephus, the commentator on the Old Testament, who says that the priests of the Tribe of Levi put pillars around the Temple of Solomon to protect it from "heavenly fire." Even supposing that the story as above told by Josephus was without foundation, it does not remove the fact that Josephus himself perfectly understood the principle upon which to protect buildings. What he termed as something in proof of the foregoing statement was in "Gibbons' Rome." During the reign of Julian the Apostate he ordered the Temple of Solomon to be rebuilt (which was destroyed). The work was somewhat under way when it was struck by lightning, as in the course of reconstruction they failed to take the precaution that was taken while it was first being built. Socrates agrees with the foregoing statement.

FIG. 10.—STEEP GRADIENTS ON ELECTRIC ROADS.

The lecturer also questioned the old theories of positive and negative conditions in relation to electrical changes, which was accompanied by numerous illustrations, concluding that positive was the presence and negative the absence of electricity, indorsing Dr. Franklin's theory on that point.

Mr. de Lew did not seem to think that electricity was a name in the least applicable; on the contrary he thought the name Lord Lytton gave it, "voil," as in every way superior. After the foregoing statements the lecturer concluded with several illustrations regarding lightning and artificial statical (so-called) electricity. The audience evinced warm appreciation of the interesting lecture given.

A GENERAL ELECTRIC SINGLE PHASE POWER TRANSMISSION PLANT.

It is not well known that the General Electric Company has exploited a synchronous system of electric power transmission, but the interesting plant installed by that concern for the Walla Walla (Wash.) Gas and Electric Company, in the spring of 1893, demonstrates this fact. The features of the installation are so distinctive and the plant being placed at a time when the company named was believed to be strenuously endeavoring to devise a system of power transmission that would, at least, be abreast of other manufacturers, lead to the conclusion that the plant in question formed a stepping stone in the development of the art. At that time single phase transmission was in successful operation at Telluride, Col., using the synchronous system of the Westinghouse Electric and Manufacturing Company, and a similar plant was about to be installed by the Standard Consolidated Mining Company of Bodie, Cal., but polyphase transmission was practically unknown in commercial circles. The Walla Walla Gas and Electric Company felt it to be imperative that the water power of Mill Creek should be utilized to operate its electric light and power plant, and the installation described was placed. That it operates satisfactorily is unquestionable, but it is improbable that similar conditions would now be satisfied by the installation of a plant of its character.

The generating station, which is situated on Mill Creek, a distance of four miles from the city receiving station, is operated by water power, the water being brought in a wood stave pipe, 48 inches in diameter, and having a total length of 6000 feet. The effective head is 66 feet and the wood pipe terminates in a sheet iron Y pipe, supplying two Pelton wheels that are 6½ feet in diameter, supplied with double nozzles and run at 100 revolutions per minute. The capacity of the wheels are 175 horse-power each, which is transmitted to the main countershaft by means of two endless compound rope drives, all as shown in the accompanying outline cut of the plant (Fig. 1.) The dynamos are belt driven from the countershaft, and the plant was laid out for double its present capacity. The synchronous motor at the city station operates power and lighting generators.

The generating station contains one 100-kilowatt single phase 2000-volt Thomson-Houston generator, having a frequency of 8000 and being composite wound, together with one 15-kilowatt 500-volt exciter, which from the manner of its use, also becomes a starting generator. These machines are shown in Fig. 2 as A and B respectively. The line consists of a single circuit of No. o., B. & S. wire, leading direct from the generating station to the city plant of the company, a distance of about four miles. This receiving plant contains one 100-kilowatt 2000-volt synchronous motor, designated as C, one 7½ horse-power direct current bi-polar starting motor, shown as D, and a small 1½ kilowatt 110-volt exciter, E, used for the fields of the synchronous motor, and for operating the station lights. The starting motor, D, drives a countershafting, to which is also belted the small exciter, E, and the synchronous motor C. The line terminates at each end at the levers of double pole, double-throw switches, so coupled that at the generating station the line may be thrown either upon the 500-volt exciter or the 2000-volt alternator, and so that at the receiving station the line may be thrown upon the bipolar starting motor, or upon the 2000-volt synchronous motor. The switchboards at the two stations contain all the forms of instruments usual for the purposes of the currents handled, the entire equipment being complete in every detail.

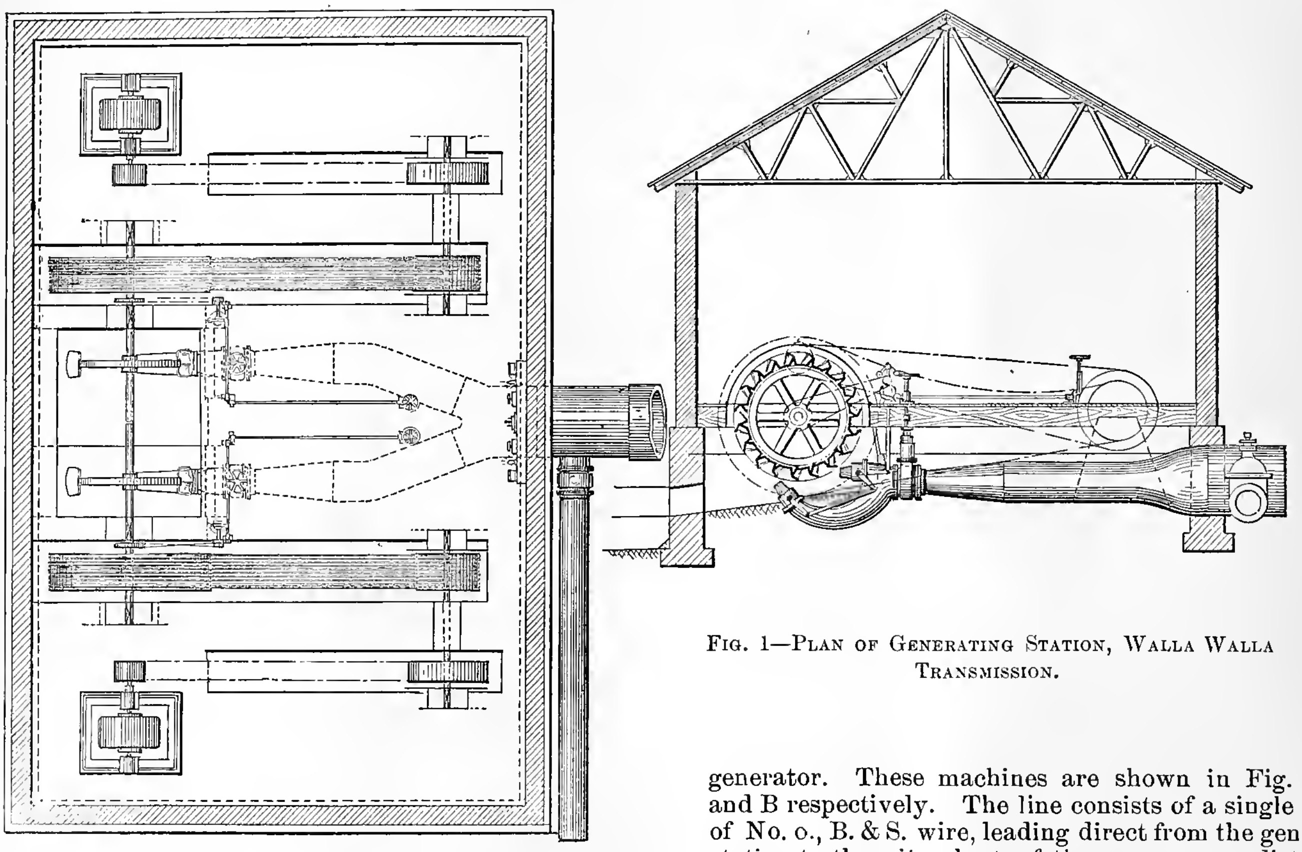


Fig. 1—Plan of Generating Station, Walla Walla Transmission.

The method of putting the plant in operation is as follows: The generating plant is brought up to speed and the rheostat in the fields of the 500-volt exciter is cut out for maximum voltage. The fields of the generator are excited therefrom, no attention whatever being

paid to the voltage of the alternator. The double pole, double-throw switch is then brought down upon the jaws forming the terminals of the 500-volt exciter, which throws its potential upon the line. The attendant at the generating station has, in the meantime, telephoned to the attendant at the receiving station that he has started up, whereupon the latter throws the line current upon the small starting motor by bringing down the switch upon its terminals, as shown in the diagram. The starting motor then brings the synchronous motor and its exciter up to speed through countershafting. The armature of the alternator runs idle in dead fields, but the exciter is brought up to voltage and connected with its pilot lamp to avoid error. When the synchronous motor has been brought up to proper speed, the station attendant telephones to the power plant to stand by the main switch, whereupon the motor attendant opens up the main switch and quickly throws in the station transformer operating the pilot lamp and volt meter on to the line through a primary switch, and then waits for field circuit of the alternator with the other hand. The motor at once comes in step, the starting motor is then shut down by throwing the clutch on its countershaft pulley, and the plant does its work with perfect satisfaction.

The method of starting was designed by Mr. W. A. Burkholder, then District Engineer for the Pacific Northwest district of the General Electric Company, and who is now General Superintendent of the Portland (Ore.) General Electric Company. Provided the speed of the synchronous motor is higher than that of the generator, the motor will invariably synchronize with the generator, and has never given any trouble whatever.

"AS OTHERS SEE US."

"Kindly accept my congratulations upon the handsome and meaty paper you have started, and let me offer my best wishes in your enterprise."—D. C. Jackson, Professor of Electrical Engineering, University of Wisconsin, Madison, Wis.

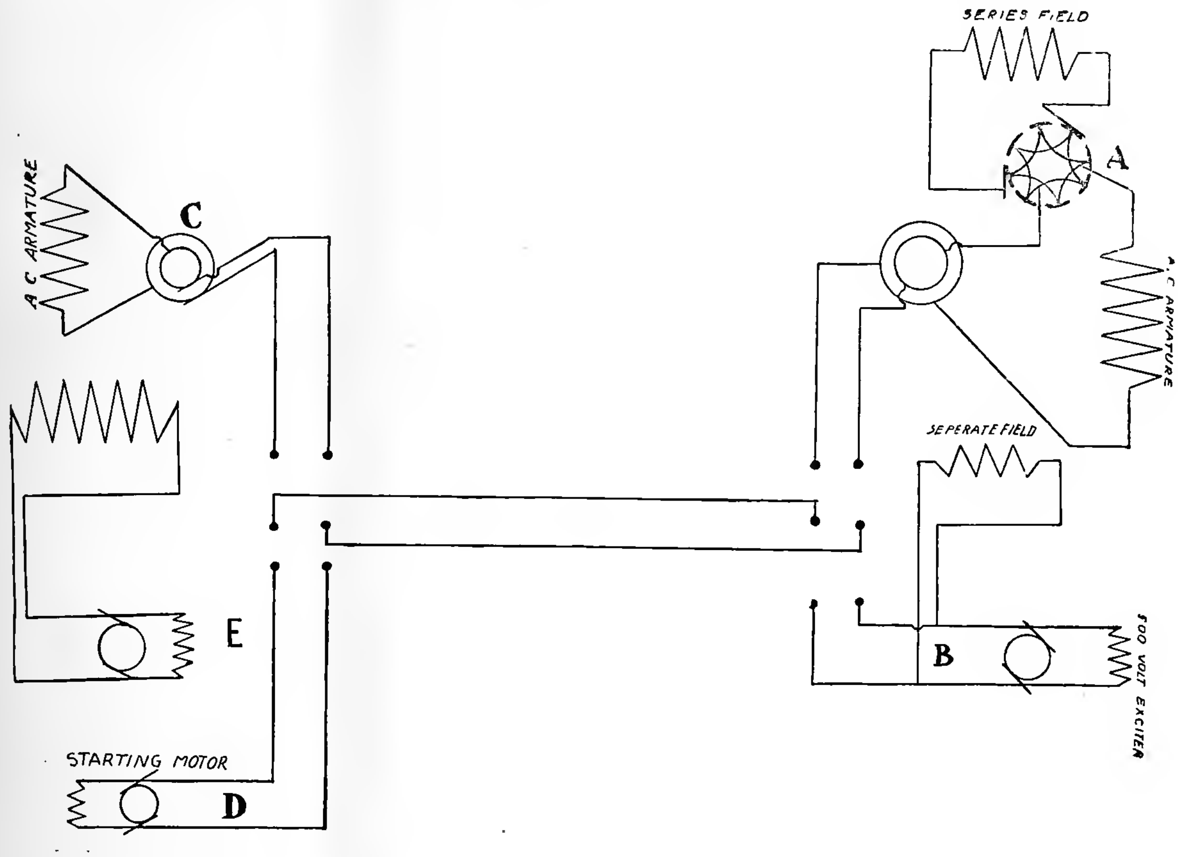


Fig. 2.—Circuit Diagram of the Walla Walla Transmission.

the appearance of the 2000-volt alternating current before closing the main switch that throws the line to the synchronous motor.

In the meantime, the attendant at the generating station, who, in compliance with instructions from the motor station attendant, has been standing by the main switch, quickly throws the main switch from the 500-volt contact to the 2000-volt contact as soon as he sees the needle of the current indicator drop back to zero, which obviously is positive information to him that the attendant at the receiving station has cut the starting motor off the line. Thereupon the attendant at the motor station, who has been watching the pilot lamp operated from the station transformer, throws the line upon the synchronous motor with one hand as soon as the lamp comes up to candle power, and immediately closes the

The advent of a serial devoted to electrical matters and interests is not an unexpected circumstance in San Francisco. Trade, scissors and paste have their necessary place in the make-up of serial literature on this coast, removed as it is some thousands of miles from other fields of like activity, but there should be other components in respectable make-up, and these are conspicuous in the present issue of The Electrical Journal.

We welcome our contemporary as an example of "honest goods" provided out of investment and work, and trust that the standard here set up will be maintained.—Industry, San Francisco.

NIAGARA'S WONDERFUL PLANT.*

The recent meeting of the American Institute of Electrical Engineers at Niagara Falls was a most important one mainly because of the attendant circumstances, the far-reaching effects and the part they will play in the history and development of the applications of electricity. The wonderful work accomplished by the Cataract Construction Company of course o'ershadowed all else in point of interest, and when, in the course of that afternoon, that portion of the programme was reached stating that "At 2 o'clock take carriages for Power House of the Niagara Falls Power Co., the Pittsburg Reduction Co., etc.," everybody was on the tip-toe of expectancy, for we were to see for the first time the big 5000 horse power dynamos. This was to be the opening day at the Power House and the first public exhibition which had been given. Promptly at 2 o'clock all were ready, and after a short drive we all reached the Power House. It is not an imposing looking structure, but it gives the impression of solidity, and has a built-to-last kind of air. The Institute button admitted all the members and guests, and when we stepped inside there it was—5000 horse power, revolving at a high speed, and yet so quietly and evenly that there was not a tremor. No. 1 was the dynamo which was running, though No. 2 was all set up. The switch-board instruments read 2400 K. W. on one side of the two-phase circuits. The power was being absorbed by a water rheostat, connected directly to the armature circuit without the intervention of transformers. The coils were of No. 2 iron wire, immersed in two large wooden tanks sunk below the level of the canal. Water was brought, under a head of five feet, through two pipes, one three and the other four inches in diameter. The supply of water was evidently no more than enough to keep the coils cool, for it was bubbling and boiling at a tremendous rate. The tanks were considerably below the floor level, and the coils were thrown in by switches, putting on a greater or less load as occasion might require. They had had a load of 5500 horse power, but at this rate the thrust of the vertical shaft was upwards, and the collars on the thrust-bearing had not yet worn down enough to carry it continuously, so they limbered up by degrees.

A piece of machinery which seemed to attract quite as much attention as the dynamo itself was the governor. It was made by Faesch & Piccard, and certainly performed its work well. It was driven by gearing from the main shaft, and operated to raise or lower the ring-shaped gates which governed the amount of discharge, thus throttling the water. When the dynamo was at its normal speed of 250 revolutions per minute, the whole load of 5000 horse power could be thrown off instantly by opening the field-switch, and the speed would only increase seven revolutions, a variation of less than 3 per cent. This was well within the guarantee, and may be considered quite a remarkable performance. The turbine wheel itself was very ingeniously arranged to meet the severe conditions. With a head 140 feet high and the amount of water required to develop 5000 horse power, the pressure on an ordinary step-bearing would have been something enormous, and would have been a very serious problem. But it was entirely provided for by forming the turbines of two wheels, one above the other, the water entering between them, and by forming the disk of the upper wheel solid, so that the weight of the shaft and revolving parts of the dynamo were entirely supported by the upward thrust of the column of water.

A trap door was provided in the floor directly over the wheels, and, on prying this up, the roaring, foaming mass of white water could be seen tumbling about below. There was a terrific downward rush of air, which made the door very hard to open. Down here in the wheel pits one could not hear himself speak, let him shout as loud as he pleased, so all the conversation I carried on with the workmen was done by writing questions on a piece of paper, to which they answered by nodding or shaking the head. Everything seemed weird in this rock-walled pit so far below the surface. Electric lights are provided, but the flaming torches cast a lurid glare over the men, who wore rubber coats, boots and hats. The water was continually dropping down as it came seeping through the walls, and in some places it was quite deep on the plankfloor. I had on my mackintosh, and had borrowed a cap from one of the men, and, with collar and trousers turned up, enjoyed it hugely. All machinery is fascinating, but this is the most fascinating place I had ever been in, and I walked around shouting to the men at the top of my voice. But nobody knew it, for that fearful screeching sound drowned out everything else. It was unlike anything I had ever heard before. It was too high to be a musical note, and can only be described as a screech or howl. And there was no let up to it. There were several explanations offered by those who heard it, and here are two, which may be taken for what they are worth. The first was that the holes cut in the hollow sections of the shaft for balancing purposes made of it a flute, and so produced the sound. The second, and to me the more rational explanation, was that as the guide wheel had 36 buckets and the turbine wheel 32, there would be produced at each revolution over 1100 vibrations, which at four turns per second might produce the required pitch. At any rate, the noise down below was horrible, while up on top scarcely a sound could be heard.

The shaft which transmits the power to the dynamo above is of steel, hollow, and 38 inches in diameter, except at the bearings, where it is reduced to 11 inches, and is solid. A thrust bearing is provided at the top, to take the difference between the weight of the revolving parts and the upward thrust of the water. The latter is calculated to amount to between 149,000 and 155,000 pounds, and depends on the quantity of water the turbine is using. The weight of the revolving parts is 152,000 pounds, so that the thrust-bearing has only about 3000 pounds to provide for.

The top of the wheel-pit is arched over with solid masonry, on which the foundations of the dynamo rest. The armature is stationary, and is supported by a cylindrical casting through which the shaft passes, guided by two bearings. The armature core is built up of sheet steel stampings, there being eleven segments to the circle, and each placed so as to break joints. The core is held together by 66 nickel steel bolts, and the conductors are imbedded in 187 slots around the periphery. The external revolving field is made up of a ring-yoke with internally projecting pole-pieces. The ring is of nickel steel, nearly twelve feet in diameter, and was forged from a single ingot weighing 120,000 pounds. It is supported by an umbrella-shaped casting called the driver, which is keyed to the tapered top of the shaft, and has the ring bolted to its periphery. The driver is provided with openings at the top, and so arranged with ventilating scoop-shaped funnels that a powerful upward draft will be created through the machine. This is necessary, as heat must be dissipated at the rate of 100 horse power. At 250 revolutions the peripheral speed of the ring is 9300 feet per minute, and the tensile stretch 5052 pounds per square inch. The designers calculate that it will be impossible for the wheels to exceed a speed of

* Exclusive Correspondence of THE ELECTRICAL JOURNAL.

400 revolutions to the minute, when the stress would be 13,000 pounds per square inch. But as the elastic limit of the steel used in the ring is 48,000 pounds per square inch, there is still a large factor of safety. It may be interesting to state that at 800 revolutions per minute the ring would burst, but the circumferential velocity would then be something like six miles per minute.

From the dynamo four cables lead to the big switches operated by compressed air, and convey the two-phase currents to the bus bars, whence it can be distributed to the users. The switches open all four wires at once, and are provided with non-arcing contacts, so that when the circuit is opened with the full load of 5,000 horse-power on the spark is no greater than with 25 amperes of direct current at 110 volts. Special volt meters, ampere meters and watt meters were designed for this plant and designated as the Niagara type. The whole electrical plant may be looked upon as a magnificent piece of execution, and as embodying the highest skill on the part of the designers. The conditions imposed were most trying, but each difficulty was met and the plant stands to-day as a model in every way. There may be a difference of opinion as to the present value of this immense work, as to its safety as an investment, but there can be nothing but praise for the engineers who designed it and for those who carried out the designs. We were all greatly pleased that we should have an opportunity to see the plant, and it was quite late in the afternoon when we took the carriages for the Pittsburg Reduction Company's works. There we examined the big rotary transformers which deliver direct current at a pressure of 160 volts, each machine giving 2,500 amperes. There are at present four in place, but the ultimate capacity of the building is eight. The 2,200-volt current is transformed in two static transformers, one on each phase, to a pressure of 115 volts and delivered at once to the motor end of the rotaries. The direct current bus bars are flat copper bars, 3 inches high and half an inch thick, and we had the pleasure of seeing them disappear through bushings in the wall. We were not admitted to the furnace room, and as the current had not been turned on yet there was nothing more to be seen.

W. E., Jr.

Trenton, N. J.

A LIFT BRIDGE ON THE CHICAGO ELECTRIC ELEVATED.

That the applications of electricity are readily able to surmount every difficulty that appears in the execution of practically every enterprise of whatever magnitude is shown by the interesting illustration of the lift bridge recently erected over the Chicago river by the Metropolitan West Side Elevated Railroad Company—the new electric elevated road of Chicago. In this instance the line current, or rather third rail current, not only operates the trains but is utalized for operating the left bridge and the constant use that it is put to from the continual passing of craft on the Chicago river has demonstaated its worth most thoroughly.

ELECTRIC LIGHT CHEAPER THAN CANDLES.

In San Rafael, recently, some ladies who had been appointed managers of a lawn party to be given by the church, were dismayed on learning that the money set apart for buying candles, was not nearly sufficient to enable the grounds and building to be properly lighted, and why the ladies appealed to the San Rafael Gas and Electric Light Company to help them out of their dilemma is not clear, but they did so, the place was beautifully lighted, and a surplus remained in the "candle" fund.

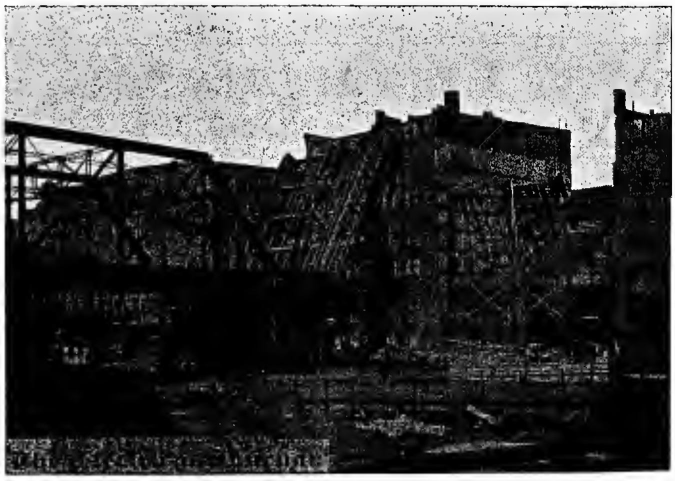
"AS OTHERS SEE US."

"Let me congratulate you—or rather the electrical interests."—F. Benedict Herzog, Ph. D., New York.

Mr. Low's new paper, The Electrical Journal, has appeared. It is attractive in appearance and contains much of interest to electrical men. —Pacific Electrician, San Francisco.

"I * * shall hope to see in your publication from time to time, articles of value on the subject [of electricity as a fire hazard.] I am sure Mr. Low can contribute materially to the literature of this branch of insurance work."—W. J. Jenks, New York.

William Henry Preece, F. R. S., Engineer-in-chief, General Post-office, London, writes in receipt of the initial number of The Electrical Journal: "I haveread your article on the 'Express' system with much interest," and "I quite long to come over and see it work."



A Lift Bridge on the Chicago Electric Elevated.

We welcome to our exchange table The Electrical Journal, a paper which will be published monthly at San Francisco. The editors are F. A. C. Perrine and George P. Low, which fact in itself is enough to insure a publication of the very highest class.—Street Railway Review, Chicago.

The Electrical Journal, edited by F. A. C. Perrine and Geo. P. Low, and published at San Francisco, appeared for the first time July 1st. It is claimed to be the newest electrical publication in America, which is certainly well founded. The publication is neat and attractive in appearance and its reading pages contain much that is of interest. The editors are both well-known to the electrical fraternity.—Electrical Industries, Chicago.

The first number of The Electrical Journal of San Francisco is out. This is Geo. P. Low's paper, and its pending appearance was mentioned in the Western Electrician, several weeks ago. It is a monthly, of handsome appearance, and from the quality of the first issue gives promise of being an important factor in the electrical advancement of the Pacific Coast region. The editors, Mr. Low and Dr. Perrine, are to be congratulated.—Western Electrician, Chicago.

The Electrical Journal.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

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F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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ANNOUNCEMENT.

Beginning with the September issue and for reasons which will appear therein, the title of this publication will be The Journal of Electricity.

GEO. P. LOW.

EDITORIAL.

POWER TRANSMISSIONS OF THE FUTURE.

It may be that the commercial success of the power transmission plants now being installed at Folsom, Niagara and other places, will create such a prestige for alternating current machinery in the minds of inventors that we will never again see a great direct current undertaking for the purpose of long-distance transmission. However, it is wise to bear in mind that the development of alternate current power transmission in this country is carried forward by the weight of the authority of two great manufacturing companies; that there are problems still awaiting practical solution which may be prejudicial to the economy of these plants; that successful long-distance direct current transmissions at high voltage are at present installed in Europe and California; that five hundred volt transmissions of ten or twelve miles are a commercial success in this country in connection with many electric railroads; and that recent improvements in the design of direct current machinery point to the possibility of the generation of higher voltage than has heretofore been attempted in large units.

Constant current generators as large as 100 K. W., producing a current of ten amperes, have been in successful operation for the past two or three years, but it is undoubtedly hazardous engineering to furnish four or five hundred horse-power to be distributed small motors by the means of such machine. Neither does the motor-transformer operate at an advantage on a circuit in which the maximum current is ten amperes and the voltage is kept within the extreme limit of 20,000 volts. On the other hand eight to ten thousand volts seems to be the limit where the current rises to forty or fifty amperes, even when generators in series are employed. While transmission by the means of a direct current is placed by these difficulties, which seem to limit the power transmitted over a single line to 250 or 300 K. W., alternating current transmission has already seen the operation of 3,750 K. W. units, and it has been announced that several of such units are to be run in parallel.

But possibly the immunity from accidents and need of repairs, said to be possessed by alternating current machinery, may be only a fancied security.

We can see the sparks at the commutator of a direct current generator, and we are able at once to perceive when they are destructive and at what time they are harmless; furthermore, the damage they may do is not likely to be instantaneous, but no man can tell when some accident along the circuit has occasioned surgings in an alternating machine, nor is mortal quickness sufficient to prevent the damage which may be accomplished by such surgings. Yet up to the present time resonance has not proved to be an insurmountable difficulty, whereas sparking at the brushes has absolutely prevented the introduction of direct current machines of large size when high voltages are to be employed.

This limitation of the direct current machine has not been touched upon in any of the discussions of either Sayres' compound wound armature in England, or of Ryan's field compounding for armature reaction in this country. The experiments of both these designers have been conducted with low voltage machines, and it has been very properly objected that in face of practical machines running sparklessly at five hundred volts and currents as high as two or three hundred amperes, no great extra expense is reasonable in order to gain sparkless commutation at lower voltages. It may be true that those of the Sayres or Ryan construction are some tenths of a per cent. more efficient than machines of the ordinary design running sparklessly, but the advantages of a slight gain in efficiency is insignificant in comparison with the possibility which these designs present of the construction and operation of large direct current units distributing power at a great distance to rotary transformers in parallel, feeding low pressure networks in direct competition with the modern multiphase alternating current systems.

Should either of these designers accomplish the generation of high voltages by the means of large direct current units, the expense of the maintenance of a commutation under ordinary wear will undoubtedly sink into insignificance in comparison with the lack of complication of other details in the system. The problem of insulation will be simplified; capacity, resonance and self-inductive effects will be eliminated, and we will see the direct current taking its place and doing its proper share of the long-distance transmission which is still remaining to be accomplished.

A VITAL ISSUE.

The signs of the times are clearly set forth in the struggle now going on between the Oakland, San Leandro & Haywards Electric Railway Company and the Southern Pacific Company for the control of the traffic between San Francisco and Haywards. It is the now familiar story

of the trolley invading the domain of the steam road, not only in its passenger business, but in express matter and freight as well, and present indications are that upon the shoulders of the Haywards electric road will fall the burden of demonstrating both in a practical and in a legal sense, that electric railways can wrest a goodly portion of traffic from steam lines. But more than this, it appears necessary that the courts should establish the fact that electric street railways are a new development in the way of transportation, which cannot be reduced to the equality of steam roads. They are a distinct creation, which owes its origin to public demand.

Viewed from an independent standpoint and broadly, it certainly seems as though every advantage was arrayed on the side of electric traction. With good road beds and unsurpassed equipments, with running time schedules practically equal to those of the steam roads and with the great convenience of being able to land one at his very door, it is hardly probable that the travelling public will care to drop the new method for the old. The Postoffice Department was quick to perceive these disadvantages, and months since adopted the electric service for the carrying of mails. Now, in the case of the Haywards electric road, an express system has been instituted for the carrying of all manner of express matter, and as a result the mighty corporation that has dominated the interests of California is evidently determined to see just how far the public will stand by the steam roads, but although the old service was vastly improved by establishing more frequent trains and by bettering the equipment, still it preferred the electric road for local travel. Finally, the State Board of Railroad Commissioners claims that the electric line comes under its jurisdiction and under this contention has requested the company to report to it. This the latter has refused to do and at present it appears certain that the question will find its way to the courts for settlement. The outcome of the contention will exert a far-reaching influence, the importance of which must not be underestimated.

READ YOUR FIRE INSURANCE POLICIES.

An insurance policy is a contract drawn between two parties whereby the first party, in return for proper consideration, agrees to insure to a pre-determined extent the party of the second part against loss or damage by fire occurring to specifically described property of the second party. A policy is, in brief, a clearly drawn, specific contract, the standard form of which has been not only sustained by the courts time and again, but which has, in the States of New York, Pennsylvania, New Jersey and Wisconsin been drafted under legislative surveillance. To disregard its stipulations, therefore, is to violate the terms of a contract, and the astounding fact is brought out during the adjustment of practically every fire, that shrewd, hard-headed business men will ofttimes so forget themselves as to enter into a firm and inviolable contract involving the value of their entire business without knowing the terms and conditions of the contract they are entering into. It is quite rational to state that ordinarily the stipulations of a policy might as well be printed in Greek for all the attention they receive.

A man insures much as he would buy a lottery ticket. He does not honestly believe it will be of service or return him any value; still there is the chance that it might do so, and when, as with insurance, the work of a lifetime may be preserved from annihilation, the policy is taken out purely as a means of self-preservation. Insurance is the body guard of commerce, and it is availed of purely in the idea of self-preservation. This being borne in mind, is it not inconceivable that its conditions should be slurred, if not ignored?

There is no disposition to review the terms of a standard form of policy, as a single clause will emphasize the points. A clause reads: "This entire policy, unless otherwise provided by agreement indorsed hereon or added hereto, shall be void * * * if (any usage or custom of trade or manufacture to the contrary notwithstanding) there be kept, used, or allowed on the above described premises, benzine, benzole, gasolene, naphtha, or petroleum, or any of its products of greater inflammability than kerosene oil of the United States standard," etc. Every electric light and power plant in the country has on hand and uses daily either gasolene or naphtha, the presence of which on the premises invalidates all insurance thereon unless special permission for its use has been granted, yet the instances where electric station managers have obtained permits for the use of gasolene or naphtha, as provided in their contracts for insurance, are extremely hard to find. In other words, a vast majority of the electric stations of the country are legally without insurance because of having invalidated their policies.

The tendency of the day appears to be toward specific insurance on the various items constituting the property desired to be covered, but in following this out it must be remembered that under an insurance policy insurance ends where segregation ends. An incident recently occurred illustrating this point in a forcible way. The receiver of an electric railway took out insurance covering a given amount "on engines, boilers and their connections and settings," believing that he had insured all the power plant equipment. The station burned, and in settling the loss it was found that among other items there was no insurance on belting, which was practically the only appliance that was totally ruined. In no way can belting be considered as a "connection" or a "setting" of engines and boilers, hence the insurance companies were under no liability for its loss.

No one expects visitation by fire, but many receive it, so as an ounce of precaution, or more properly, of business prudence, read your policies and understand the conditions of the contract obligations you have agreed to abide by in case of fire.

Literature.

TRANSMISSION LINES, by A. V. Abbott.

It is a great pleasure to have been given the opportunity of looking over the proof sheets of such a book as A. V. Abbott's forthcoming volume on "Transmission Lines." Recently a writer in one of the electrical journals complained that no book had been issued on engineering problems of line construction, stating that the reason was probably to be found in the fact that the construction had been intrusted to men of practical experience rather than to theoretical designers—to linemen rather than to engineers. This may, perhaps, have been true in the construction of most telegraph pole lines, or, it is said, may account for the greater or less disorganization of telegraph service after every heavy windstorm, and undoubtedly explains the waste of thousands of dollars in faulty underground construction by most of the electric light and railroad companies throughout the country. Mr. Abbott's book is the book of an engineer and treats the problem as one of engineering.

The telephone companies were one of the first to recognize the importance of erecting their pole lines in such a manner that their service should be continuous in spite of climatic conditions, and of doing their underground construction for permanence rather than for simple cheapness. With the expiration of the Bell telephone patents and the termination of the Western Union contract we are bound to see a reorganization of both the telephone and the telegraph business throughout the country, and in the forthcoming contest we will undoubtedly see fruits of the efforts of the engineer where the inventor and lineman have heretofore held sway.

The lead in the competition will be taken by the company which will give the best service and at the least cost, which means the best apparatus, the best lines and the least repairing, all of which require the best and most thoroughly trained engineers.

THE LAW OF INCORPORATED COMPANIES, by Allen R. Foote and Chas. E. Everett, 3 vols., 8vo., 2930 pages, sheep. Cincinnati, 1892-93. Price, $15.00 For sale by the Bancroft-Whitney Company, San Francisco, and The Electrical Journal.

The trite adage that "Any man who is his own lawyer, has a fool for a client," is not to be impeached, but in no way will a belief in the precept preclude one from posting himself regarding the general laws which govern the business he is engaged in, and in fact, the business manager of corporate interests, who does not keep himself well informed as to fundamental legal points, is remiss in a very important item. The volumes presented expound the laws of the various States and Territories of incorporated companies operating under municipal franchises, such as gas, electric light and power, telephone, street railway and water companies; hence, they throw the light of legal knowledge upon the proper methods of procedure in the organizing, incorporation, powers, liabilities, franchises, and general management of commercial interests that are generally electrical in character. Of the author, Mr. Allen R. Foote is well known to electrical interests, because of his work on the "Economic Value of Electric Light and Power," his special agentship for electrical industries in the United States census, and his membership of the American Institute of Electrical Engineers. Aside from Mr. Chas. E. Everett, A. M., LL. B., who is editing attorney for the work, a resident attorney in each State has been appointed as co-editors, among whom are noted such prominent personages as William A. Blount, of Florida; Charles H. Aldrich, ex-Solicitor General of the United States, of Illinois; Chief Justice Henry M. Blake, of Montana; Anthony S. Keasbey, of New Jersey; James W. Eaton, of New York, and Judge George H. Williams, of Oregon. Indeed, the names associated in the compilation of the work, alone, guarantee its thoroughness and accuracy. It is, in brief, a work that no lawyer or manager can afford to be without.

ON THE DEVELOPMENT AND TRANSMISSION OF POWER, by Wm. Cathorne Unwin, F. R. S., London, 1894. Published by Longman, Green & Co.

The transmission of power to a considerable distance has only attracted much public attention in this country since the introduction of electricity as a means of energy transformation. In consequence, even our engineers are in danger of forgetting that for many years thousands of horse-power have been economically distributed through New York by the means of steam pipes laid in the streets; that hot water distribution was for a time successful in Boston; that natural gas differs but little from a fuel gas, which it is possible to manufacture cheaply, and that long distance hydraulic transmission has furnished the power for mining millions of dollars worth of gold in California. It is true that each of these examples is the special solution of a special case, but it is also true that such solutions are the essence of successful engineering, and it is wise to look over the means already at hand for the development and transmission of power, before we decide that any one is necessarily suitable for a given case. The first impression on reading Prof. Unwin's Harvard lecture on "The Development and Transmission of Power" is one of surprise that an engineer of high standing and wide attainments can be found who seems to believe that power may be transmitted in many cases more economically by the means of high pressure water or compressed air, than by the means of electricity.

And again, one is surprised by the magnitude and success of the power plants described, using those methods which are successfully installed in Europe. There is much food for thought in all of this, and an engineer can scarcely afford to neglect the consideration of many of the advantages which this book calls to our attention, present in other means of distribution, even when he may be considering the installation of an electric plant. The generation and distribution of power is here considered as a whole in a manner difficult to express more completely in so compact a form; and central station engineers may find in the chapter on the "Condition of Economy and Waste in Steam Engines," "The Cost of Steam Power," and "The Storage of Energy," many of the conditions clearly expressed, which are useful in determining the necessary arrangement, and methods of handling apparatus in order to reduce the great consumption of coal in even our best equipped stations, which has been reported by the committee of the National Electric Light Association. In the treatment of hydraulic motors one is impressed by the necessary inefficiency of the common hydraulic elevator, using, as it does, the same amount of water for all loads, and it seems a small wonder that the introduction of a successful electric high speed elevator has been followed by a very wide spread use. The problem of a small motor which shall use hydraulic power economically, will hinder greatly this type of transmission wherever the cost of water pumped becomes a serious consideration, as has been shown by the experience gained at both Holyoke and Geneva. Even where water power is abundant, and the cost of pumping low, there yet remains the problem to be solved whether it is not finally more eco-

nomical to install electric machinery which will generate current directly available for other uses than the development of power, and by the increased efficiency of motors save much of the expense of mains and turbines in the original water power installation.

The complete description given of telodynamic or wire rope transmission confirms one in the belief that save for small powers at short distances, such as from one section of a works to another, there is little likelihood that this method will be extensively used in the future. It is unfortunate, however, that no mention is made of the telodynamic transmission at the Calumet & Hecla mine, in which a rope has been for many years successfully run at 12,000 feet per minute. It is not difficult to perceive that transmission by the means of compressed air has received Prof. Unwin's greatest attention and favor. We already know that very few pneumatic plants have been displaced in mining, and it is an open secret that for deep mines the economy of working is considerably greater with compressed air than with electricity, in spite of the fact that neither the compressors or air drills are often worked under the greatest conditions of economy. The two chapters on the "Transmission of Power by Compressed Air," and the "Theory of Air Transmission" discuss very carefully the problems of the compressors, mains and motors, taking into account all the subsidiary losses of energy which are involved, and one is forced to the conclusion that a high efficiency of transmission and distribution is easily attained by the means of compressed air.

The economy of plant is not by any means so completely established, as it is difficult to acknowledge that the cost of installation of machinery is less than with electricity, and one would hardly let the statement go unchallenged that one-fourth pound of coal per horse-power hour used in reheaters, is an inconsiderable quantity.

The distribution of power by steam and gas is not as fully treated as the cases already cited, the chapter on steam distribution being taken almost entirely from Dr. Emery's published writings, while the distribution of heat by the means of exhaust steam is entirely neglected, though this has become a very important adjunct to many power stations installed in this country. In many cases such a distribution is claimed to be of more value to the financial economy of a station than the availability of water for condensation.

We are inclined also in this country to look for a substitution of fuel gas for natural gas in power transmission, and it is disappointing to find in Prof. Unwin's book so pessimistic a view taken of the future possibilities of the economical production and distribution of producer gas.

The two chapters on "Electrical Transmission," and the chapter on the "Utilization of Niagara Falls" possess a peculiar interest on account of the position of Prof. Unwin as one of the original advisers of the Niagara Falls Power Company. The history of electrical power transmission is only beginning to be written, and it is painfully evident in this book that to the general engineer there is but little data available for estimating the cost of construction, maintenance and operation of an electrical transmission plant. Prof. Unwin has hardly advanced beyond the position of Prof. Forbes' lectures on "Electrical Distribution," while in citing and applying Kelvin's law he makes the serious common error of neglecting the condition that the solution only holds for the current being considered a constant. Comparing the power delivered by the complete list of long distance electrical power transmission given by Unwin, and the capacity of the plants installed since his data was collected, one is impressed with a very practical proof of the efficiency of this system of power transmission.

In the chapter on "Niagara" we have a clear outline history of the undertaking, and it is a relief to read an account of the Niagara Company, its commission and engineers, which is free from the ill-feeling and hard names which have been used so generously in connection with this plant. The volume as a whole is a most valuable addition to the literature of central station construction and power distribution, and presents much matter which no engineer can afford to neglect.

SPECIAL AGENTS' ELECTRICAL HANDBOOK, by A. M. SCHOEN, Assc. Member A. I. E. E., Electrician South-Eastern Tariff Association. Atlanta, Ga., 1894, 82 pages, 16mo, leather. Illustrated. For sale by THE ELECTRICAL JOURNAL. Price, $1.00 each, post free, with liberal discounts for large orders.

This little book, which was designed for the guidance of special agents for insurance companies and may be read with advantage by all electricians, deals with electricity in its bearings upon insurance inspections. The book was printed by the South-eastern Tariff Association, and proved to be so popular that the small edition issued was soon exhausted. The author, with the consent of the association has transferred his copy-right to The Spectator Company, which has issued a new edition, *enlarged and improved.* Mr. Schoen has made many and important additions to the Electrical Hand-Book: which also contains numerous illustrations of electrical appliances and descriptions of imperfect work not in the first edition, together with full instructions to enable inspectors to ascertain the hazards of all electrical machinery and appliances.

THE PACIFIC COAST GAS ASSOCIATION.

The third annual meeting of the Pacific Coast Gas Association was held at San Francisco on July 16–17, during which the following papers were read and fully discussed: "The Economy of Small Works," John Clement; "Welsh Anthracite Coal," John L. Howard; "Treatment of our Customers," O. M. Gregory; "One Year's Experience with Wellsbach Burner," E. C. Randall; "Calcic Carbide," E. C. Jones; "Technical Gas Analysis," J. Bryant Grimwood, "Producer Gas," H. E. Adams.

The retiring President, Mr. C. W. Quilty, of San Jose, also delivered an interesting address, after which the business of the association was transacted. An important action taken was the selection of the American Gas Light Journal as the official organ of the association, in which publication the proceedings of the association may first appear.

At the second days session the following officers were elected for the ensuing year: President, E. C. Jones; Vice-President, F. H. Eichbaum; Secretary and Treasurer, John A. Britton. These officers will constitute an Executive Committee and an Advisory Board. The directors elected are as follows: O. M. Gregory, San Jose; G. W. Wilson, Vallejo; C. O. G. Miller, San Francisco; B. U. Steinman, Sacramento; and S. B. Cushing, San Rafael.

The social features of the convention proved most enjoyable, the first of which was the superb banquet held at the new Delmonico on the evening of the first day of the session. After adjournment on the second day, there was an excursion on the bay and luncheon at the North Beach station of the San Francisco Gas Light Company. In the evening a theater party was held at the Columbia, which concluded the most enjoyable and profitable session yet held.

THE DENVER CONSOLIDATED TRAMWAY COMPANY.

The Company of which the present system is the outgrowth, was organized February 5, 1885, as the Denver Electric and Cable Railway Company, the earliest effort of which was the operation of a conduit system of electric railway on Fifteenth street, in Denver, Col. Mr. Rodney Curtis, now President of the Tramway Company, was the first manager of the original company. On May 4, 1886, the Tramway Company was organized and shortly after built and placed in operation about twelve miles of cable road, constituting the Broadway, Colfax and Fifteenth Street lines, the latter of which displaced the conduit electric line referred to. The South Broadway Electric line, which was put in operation on Christmas day, 1889, was the first trolley road operated by this company, and to-day the Tramway Company has in operation eighteen lines, all being electric, as the cable roads were abandoned in 1893. These lines are the Broadway, Colfax, Nineteenth, Twenty-second, Stout, Lawrence, South Tremont, Eleventh, Harmon, Pearl, University Park, South Broadway, Park Hill, Berkeley, Rocky Mountain Lake, Agate, Ashland and the Riverside line, making in all 99.29 miles of single track. The motors used are of the Westinghouse, Thomson-Houston and General Electric types.

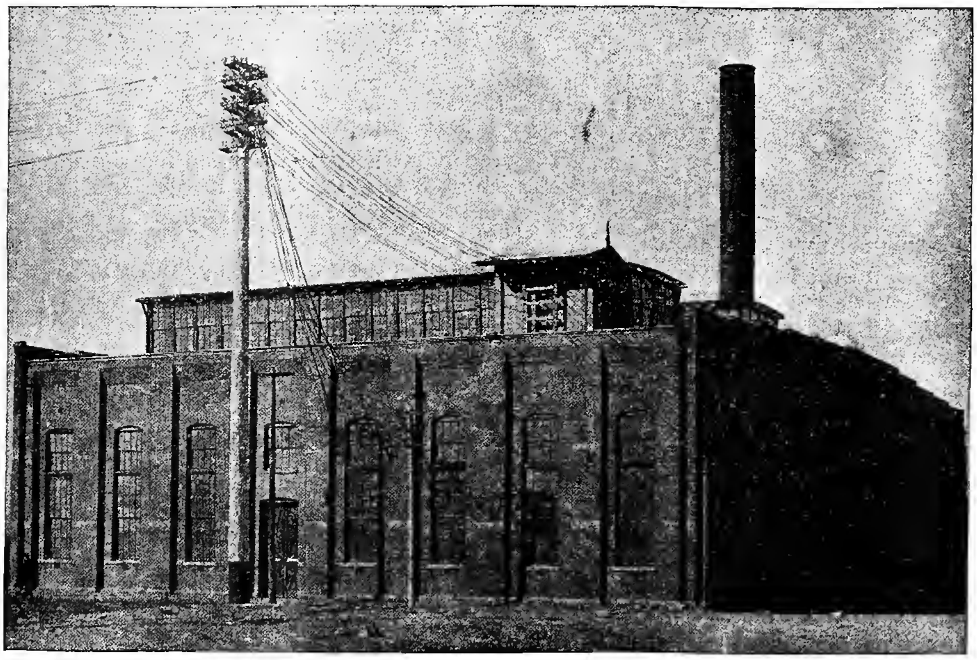


Fig. 2.—The Denver Consolidated Tramway Company.

The Grand Avenue Station, the interior of which is shown in Fig. 1, is mainly equipped with type D62 T. H. railway generators, there being also one 250-kilowatt General Electric multipolar generator. All machines are driven from a counter-shaft, operated in turn by a large twin Corliss engine. Either of the railway lines can be operated from this plant.

It was at this station that one boiler of a battery of twelve tubulars exploded on January 30th last, but the accident, though serious, did not materially delay operations, as in a few days the plant was again in operation by steam supplied from locomotives that had been run up alongside the station. The Blake-street Station, on Blake street, near Thirty-second, and which at that time carried most of the load, contains two General Electric multipolar 500-kilowatt generators, and also one Westinghouse 500-kilowatt multipolar generator. These dynamos are each belted direct to Hamilton Corliss, or Reynolds Corliss engines, and together with the necessary boilers, etc., constitute the plant. There is, however, room for two more 500-kilowatts units, and at present it appears as though a 500-kilowatt Siemens-Halske direct connected generator would be placed in the near future. The switchboard is of white marble, with phosphor bronze trimmings, and so arranged that it may be extended to almost any capacity. Water lightning arresters are used behind the switchboard.

The Tramway Company has several well-stocked car-barns, and all of its equipment is of excellent design and finish, both for summer and winter travel, as will be apparent from the accompanying illustrations. Since its inception the road has been under the superintendency of Mr. C. K. Durbin, to whose ability the general superiority of the equipment and service is largely due. Without doubt Denver owes much of its growth and prosperity to the enterprise of the Denver Consolidated Tramway Company.

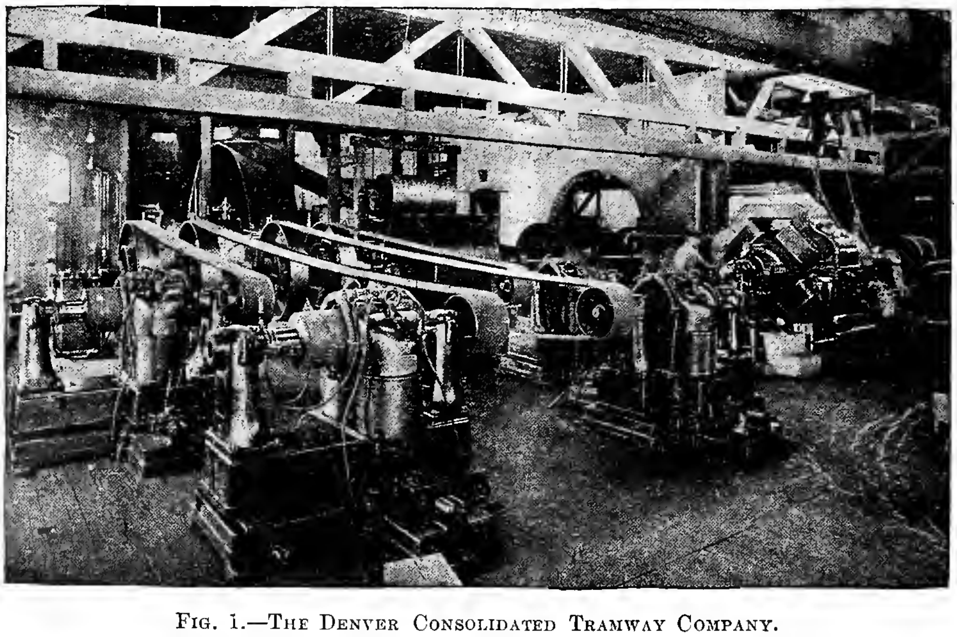


Fig. 1.—The Denver Consolidated Tramway Company.

ELECTRIC POWER TRANSMISSIONS—ACTUAL AND PROSPECTIVE.

The month just closed will prove a memorial one in electrical circles of the Pacific Coast, if not by the world, not only because of the successful starting of the Folsom-Sacramento plant, but because of the awarding of contracts for the erection of other yet more interesting power transmissions.

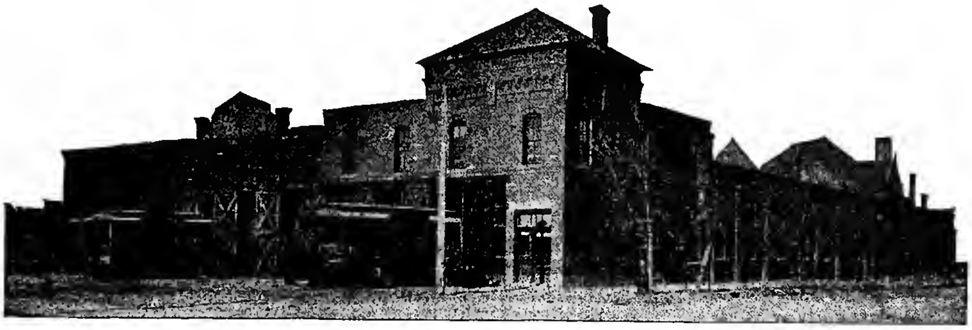


Fig. 3—Car Barns of the Denver Tramway Co.

At 4 o'clock in the morning of July 13th, the people of Sacramento were roused by the booming of 100 guns, the signal which had been arranged to announce the successful transmission of power from the Folsom dam across the American river to Sacramento river, a distance of 22½ miles. This installation is in some respects the most noteworthy ever undertaken. It operates at an initial potential of 11,000 volts, its four generators have a capacity of 750 kilowatts or about 1000 horse-power each, and are, therefore, the largest three-phase dynamos ever constructed. The entire equipment is, or when completed will be in duplicate, and at present a double pole line has been erected over the entire distance, but only one generator is in use. The present condition of the plant is largely temporary regardless of statements published to the contrary and a description of it at this time would be premature. But a single generator is running, owing to the breaking of a temporary dam and the wetting of a second dynamo that had been sent out. At Sacramento, a 500 horse-power, three-phase motor is driving two Edison bi-polor and one General Electric street railway generator and also a 10 horse-power motor for operating a toboggan slide that the Central Electric Railway has erected in East Park. In fact, the necessity for obtaining power for operating the Central street railway system, which is owned by the Sacramento Electric Power and Light Company, compelled the starting up of the Folsom transmission before it was ready. This statement of the actual condition of affairs, however, does not detract in any way from the value of the enterprise or its influence upon the development of similar enterprises, but, to the contrary, enough has been accomplished to satisfy the most exacting as to the feasibility of the scheme and the thorough practicability of the methods and apparatus used.

Following close upon the starting of the Folsom transmission comes the announcement recorded in the news department of this paper, that the General Electric Company has secured the contract for transmitting 2,500 horse-power a distance of 14 miles from the big Cottonwood dam to Salt Lake City, and, most important of all, that the same Company has accepted a contract under which it agrees to deliver 1000 horse-power in Fresno, Cal., from a fork of the San Joaquin, thirty-five miles distant. This plant will probably be in operation early in January. In Southern California many ambitious projects are under way and will be installed if substantial backing is to effect it. Principal among these are the Power Development Company, of Bakersfield, which has issued specifications and is now receiving propositions, as described elsewhere.

Over topping all, however, is the announcement just made of a gigantic electric power transmission scheme in which the organizers have very dextrously arranged so that they will have as generating power the water from the immense debris dam soon to be built at Deguirie, six miles above Marysville on the Yuba river. Acting upon the recommendation of the California Debris Commission the last legislature appropriated $250,000 for the erection of a mining debris dam at Deguirie, which amount it is believed will undoubtedly be increased by an appropriation of $ 350,000 from Congress. The Deguirie dam will develop 70,000 horse-power, the right to use which has been secured by Assemblyman R. I. Thomas, of Nevada county, who states that he has sufficient California capital behind him to complete the plans.

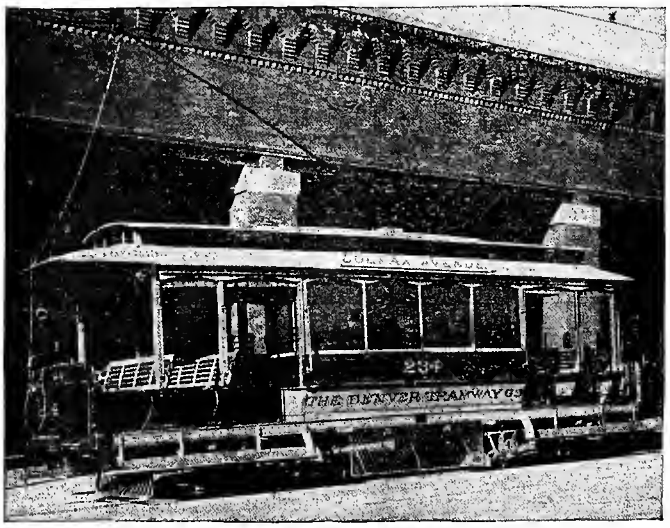


Fig. 4—The Denver Tramway Co.

Electro-Insurance.

THE LESSONS OF A FIRE.

It appears from the report rendered by George P. Low, appraiser for the various insurance companies represented in the fire which destroyed the power house and car barn of the Seattle (Wash.) Consolidated Street Railway Company early on the morning of June 20th last, as described in the last issue of this publication, that in addition to a large amount of supplies, the burned station contained the following dynamos, with their usual wiring and switchboard appurtenances:

7, Type D82, 80 horse power, Thomson-Houston, 500-volt railway generators.

2, 60-kilowatt Edison, 500-volt railway generators.

1, 60-kilowatt National, 500-volt railway generator.

2, 1000, 16-candle power, National alternating incandescent lighting dynamos, with exciters.

2, 50-light Western Electric arc lighting dynamos.

25, Electric street railway passenger cars and equipments, and

1, Electric wood hauling car.

The list given represents practically every type of dynamo-electric machinery used, as it includes 500-volt direct current generators, 2200-volt alternating current generators, and 2500-volt arc lighting dynamos. The equipments of the electric cars, though serviceable, were mostly of an inefficient type, no longer manufactured or for sale, and which, therefore, would not find a ready market if rebuilt. The seven D62 railway generators and the electric cars and supplies named, which were the property of the Seattle Consolidated Street Railway Company, alone are considered in the report.

The dynamo and engine room was located on the ground or basement floor, and as the fire originated or burned most fiercely in the car barn, constituting the upper story, the injury to the power plant was principally due to water, the falling of car equipments, etc., and of burning timbers and cars. From information and evidences at hand, it is clear that the efforts of the Fire Department were exerted in the direction of keeping the fire from reaching the power plant as far as possible, in order to accomplish which, several powerful streams were kept playing upon the dynamos, and in the dynamo and engine room during the fire. As a result, and although the building was entirely destroyed, the dynamos were thoroughly soaked and buried in burned debris. At the outset the prospect of saving the generators seemed remote, but it transpired that the method adopted by the Fire Department in playing continuous streams of water upon the dynamos and in the dynamo room, was to be highly commended.

The task of drying out and testing the generators, continues the report, proved long and laborious, not only because of the almost infinite care and watchfulness that must be exercised to detect any adverse symptom that might develop during the process, but because of the necessity of using the crude and more or less unsatisfactory means at hand for prosecuting the work. On June 28th, three D62 generators had been dried out and tested, and set up and put in operation under the direction and supervision of the Insurance Appraiser. The third day following, a fourth generator was placed in serviceable condition and put in operation, and on July 3rd, the Consolidated Company, through its proper representatives, released the insurance companies from further liability on these dynamos. The fifth dynamo was placed in service July 4th, but the armatures for the remaining two dynamos proved refractory, and despite the most careful treatment they burned out; the first while under potential test, and the second on July 9th, after having been in actual service but five hours the previous day.

The Appraisers' report shows the sound values of these seven D62 generators to be $10,500. The cost of placing the same in service again in first-class condition, and including an item of $400 for labor (which local conditions rendered excessive) was $1,306.15, or 12.4 per cent. of the sound value. Under ordinary conditions regarding labor, this ratio would have been reduced to almost 8 per cent.

The switchboard was totally consumed, except the circuit-breakers, which were rewound and remounted at a cost of $7.50 each, and are now in regular use. The sound value of same was $240, and the damage $30. The car equipments, electrical and other similar materials and supplies were destroyed beyond reclaim, except as junk.

Circumstances indicate that the fire originated either through spontaneous combustion or incendiarism, but certain it is that the fire was not due to electricity, as, when first discovered, it was in a portion of the car barn that was not lighted by or wired for electric lighting. It was the invariable practice to remove the trolley wheel from the trolley wire when the cars were in the barn, hence, there is no probability that the fire was caused by defective electrical equipment in a car. The floors were of rough 2-inch planking, with cracks between planks, the ceiling below was finished with ⅞-inch tongued and grooved stuff; the floor had been soaking oil for three or four years, and although orders had been given regarding the disposal, etc., of oily waste, it is possible that such orders were disregarded and that spontaneous combustion resulted therefrom. On the other hand, the fire when first seen, was in the immediate vicinity of a doorway leading out of doors, and which was never closed, as it had no door. Regardless of orders to the contrary, the car barn was unoccupied at the time of the fire, as the night barn foreman and his helper had, in violation of instructions, taken out a special car to take another employee home. The engineer and dynamo tender were at their work in the engine room; it was about 1 o'clock in the morning, the car barn was vacant, all its doors were wide open, and an incendiary would have found a most favorable opportunity. No direct evidence of any nature is available, hence, it is impossible to reach a conclusive opinion regarding the origin of the fire.

The report offers the following comments as the principal lessons of the fire:

1. Railway generators are not susceptible to great injury from water alone, if not in operation when wetted,—the average damage from such cause being, approximately, 12.5 per cent. of their value.

2. The injury to railway generators, by fire and water together, will not ordinarily exceed approximately, 50 per cent. of their value, if the frames and shafting remain sound.

3. The losses on switchboards and electrical supplies of all descriptions, if burned, will be practically total.

4. The losses on switchboards and electrical supplies by water, will rarely exceed 25 per cent. of the sound value of any article.

5. The water damage to car motors and equipments, will generally average less than 20 per cent. of their values.

6. The damage to car motors, etc., by fire, cannot well be pre-estimated, because of the many forms of motor equipments, and the fact that owing to recent

great advances in the art of car motor building, the type of motors now most in use are neither manufactured or demanded. Forty per cent. of the value would, however, ordinarily be sufficient to rebuild the motor, provided the frame be sound.

7. A careful, competent and conscientious apraisement is necessary on the damage to all electrical machinery injured by fire or water.

8. Since fires in electric power plants spread with such astounding rapidity, sometimes, as in the present instance, enveloping the entire structure in a very few seconds, there appears to be emphatic need for the introduction of reliable thermostatic alarms and automatic sprinklers in such risks, in order, (1), that the engineer may receive instant notification of fire, and shut the plant down, and (2), that the damage may, so far as is possible, be by water rather than by fire.

In conclusion, the report compliments Messrs. B. D. Smalley and B. B. Broomell, for their cordial support in facilitating the work of the appraisers, and to Mr. W. J. Grambs, appraiser for the assured, for the "honorable and fair-minded manner in which he conducted the appraisement on the part of the Seattle Consolidated Railway Company."

METALLIC SODIUM PRECIPITATED BY ELECTRIC LEAKAGE.

The eighth fire report of the Electrical Bureau of the National Board of Fire Underwriters, cites an interesting case, illustrating a new source of danger from electric wires, which was recently brought to the notice of the Boston Board of Fire Underwriters by the accidental sounding of an automatic fire alarm in that city. The following account is given by F. E. Cabot, Superintendent:

"For some time past a slight smoke has been noticed issuing from the casing about the electric light wires in the basement, where they enter from the street. When the insurance inspectors arrived and the casing was removed, it was found that a peculiar substance had accumulated about the wires which, when moistened and struck with any hard substance, would give off flashes of fire. All around this point the woodwork was covered with a thick liquid which had dried in places to a white substance resembling discolored salt, and which was slippery to the touch and strongly corrosive. The wood itself was soft and badly discolored.

"The deposit discovered about the wires proved, upon analysis, to be mainly metallic sodium. Metallic sodium is a substance very difficult to obtain except by the aid of the electric current. It is exceedingly combustible and unites so readily with water that its presence in a damp cellar would be impossible under ordinary conditions. When it unites with water hydrogen gas is given off and at the same time a considerable amount of heat is generated. Under certain conditions this heat would be sufficient to ignite the hydrogen gas. Hydrogen gas and air will form an explosive mixture. Hence, the greatest danger lies in the liability of an explosion if the gas should become ignited.

"The explanation of the appearance in a damp cellar of a substance so combustible and unstable in the presence of moisture as metallic sodium, is given as follows: The metallic sodium was undoubtedly the product of an electrolytic decomposition of impure sodium hydrate. This sodium hydrate came from the cement mortar used in laying the brick wall of the basement, upon which the wires were supported. Some of the hydrate may have possibly worked its way through the wall from the cement used in the foundation of the paved street (Washington street), immediately adjacent.

"The electric current which caused the electrolytic action was due to a leak inside the casing, from one of the mains to another. The leak was produced by the action of the sodium hydrate on the insulating covering of the wires. This covering was what is known as "Weather-proof Insulation," which consists of a cotton braiding covered with tar. Such a material is readily attacked by sodium hydrate and its insulating properties destroyed. Moreover, the sodium hydrate itself furnishes a good path for the current when it has once penetrated through the insulation.

"This case is especially interesting in connection with several of the explosions which have occurred in underground conduits, usually attributed to a leak in the gas mains. In the London papers recently it has been suggested that metallic sodium may possibly have had something to do with these explosions. This, however, appears to be the first instance in which the appearance of metallic sodium has been proved and a complete explanation of an actual case given."

PERSONALS.

Dr. F. A. C. Perrine, of the Leland Stanford Junior University, and Mrs. Perrine, are spending the summer vacation on the Atlantic Coast.

Among the prominent guests of the recent meeting of the Pacific Coast Gas Association were Mr. Walton Clark, of Philadelphia, President of the American Gas Light Association; Mr. O. N. Guldlin, of Fort Wayne, President of the Western Gas Construction Company; Mr. Daniel R. Russell, of St. Louis, of Barker, Russell & Co., and Mr. E. P. Callender, of New York, publisher of the American Gas Light Journal.

The University of Wisconsin has conferred the honorary degree of LL.D. upon two men of national reputation on account of their great services in the interest of engineering and the industries. The first of these is Edwin R. Reynolds, of Milwaukee, Wis., designer and builder of the Reynolds Corliss engine. The degree was conferred upon Mr. Reynolds in recognition of his position as an expert of the highest rank and of international authority as a steam engineer, and on account of his remarkable ability and success as a designer and inventor. The second is Don J. Whittemore, of Milwaukee, Wis., Chief Engineer of the Chicago, Milwaukee and St. Paul Railway. The degree was conferred upon him in recognition of his distinguished services in the railway interests of the country.

VAN LEER EASTLAND—IN MEMORIAM.

A scroll was presented and ordered spread upon the minutes of the annual meeting of the stockholders of the Oakland Gas, Light and Heat Company, held on August 5th, as follows:

"In memoriam---Van Leer Eastland died September 8, 1894, after twenty-seven years of active service in the field of gas industries and more than forty years after his first engaging in the work of the San Francisco Gas, Light and Heat Company.

"His was a character worthy of emulation by all who survive him. Zealous in every just cause, loyal to all his trusts, kindly in all his ways, honorable because honesty was his creed, esteemed by those with whom he came in daily contact and respected because of his manliness, it becomes this body, of which he was an earnest member, to pause in its progress and say of him as was said of that noble Roman, 'His life was gentle and the elements so mixed in him that Nature might stand up and say to all the world, 'This was a man.'"

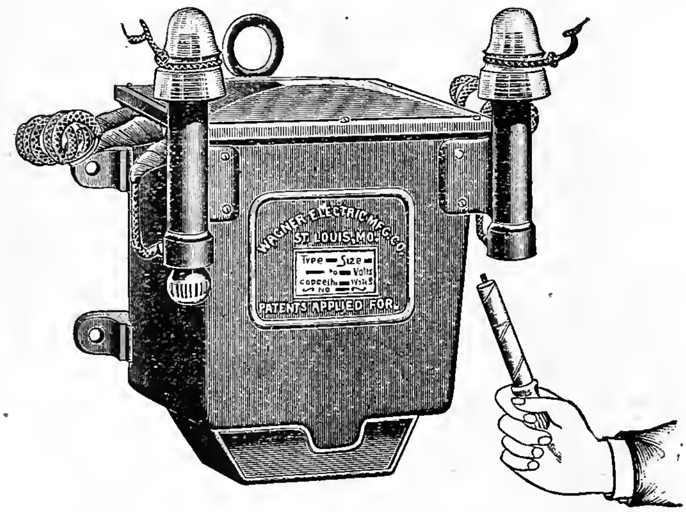
The Trade.

In responding to advertisements in this publication, please mention The Electrical Journal.

A DEPARTURE IN FUSING TRANSFORMERS.

The Type D transformer of the Wagner Electric Manufacturing Company marks a new departure in the mechanical design of transformers. The difficulties attending the use of primary fuse cutouts in the transformer box have led some manufacturers to entirely abandon their use in this way, as it seemed impossible to design a fuse block which would not arc at times when the fuse blew on a bad short circuit. This arc would in turn cause a short circuit between the two blocks, and usually burned out the whole cutout as well as the transformer. Appreciating the fact that the transformer box is the best and most convenient place for the primary fuse, the Wagner Company at last provided a cutout which is claimed to meet all possible requirements, with none of the objections or weak points of fuse blocks heretofore used.

The first requirement is a fuse block which can never arc and the second is to have the fuses so placed that they will be separated entirely from each other and from the transformer box, although supported by the latter. The new Wagner fuse plugs are each carried in a separate cast iron shell, attached simply by means of screws to either side of the transformer box. The third requirement is that fuses should be readily replaced without tools of any kind. Not only are no tools of any kind required to remove the Wagner fuse plugs and re-



A Novel Transformer Fuse.

place fuses thereon, but there is no cover or lid of any sort to remove or raise in order to reach them. The end of the plug extends below the protecting shell, and three or four turns of this knobbed end releases the plug, which may then be withdrawn.

The plug and its insulating shell are not made, as usual, of porcelain, which is very brittle and easily broken, but are turned out of lava, as refractory a substance as any known, and which has about five times the strength of porcelain. With the smallest size fuse plugs, the Wagner Company claims to have repeatedly broken a current of fifty amperes at five thousand volts, without producing an arc, or which left any traces on the plug. They, therefore guarantee these fuse plugs not to arc with five thousand volts.

After securing this perfect fuse cutout, the Company took up the matter of transformer installation, with a view to reducing its cost by rendering the transformer more convenient to hang and connect. By providing cross arm and wall hooks to be bo ted to the transformer lugs, the most convenient hanging of the box itself was obtained and eventually it was determined to attach the wall brackets ordinarily used to the transformer box, thereby obviating the cost of brackets and the labor of drilling walls, etc. The result was a combination of transformer, box, primary fuses and service wire brackets, in one compact piece of apparatus, as shown in the accompanying cuts.

The Sterling Supply Company, 54 Second street, San Francisco, represents the Wagner Electric Manufacturing Company on the Pacific Coast.

THE LUNDELL EXHAUST FAN.

The design of the Lundell motor lends itself most readily in application to exhaust fan work. The motor, being iron clad, is almost wholly enclosed and easily permits of connection by radial arms, spider, or bolts to any of the many forms of exhaust fans now to be found in the market.

It has been the practice of manufacturers of exhaust fans to supply a bearing in front as well as in the back of the fan, but in the present application a shaft is carried which may be horizontal or vertical, in two bearings in the motor frame itself, not supporting the shaft in any sense from the fan ring. This course insures perfect alignment and noiseless running.

All Lundell exhaust fan outfits are made with horizontal shafts, unless otherwise ordered, and are invariably made so that the direction of the flow of air is from the motor toward the fan. If it is desired to operate the fan with a vertical shaft or to drive the air through the fan and over the motor, it should be specifically so stated in the order. With the standard horizontal shaft fans. an adjustable thrust bearing, as shown in cut, is provided. When the flow of air is desired contrary to the standard direction, a button and thrust bearing is placed at the rear of the motor. In the horizontal shaft fans, lubrication is effected in an oil receptacle enclosing a step at the bottom of the shaft, and a graphite or other self-lubricating bearing (never a grease-cup or oil bearing) at the upper end of the shaft.

The Lundell dynamos and motors are handled by Thos. Day & Co., San Francisco, the Pacific Coast agents for the Interior Conduit and Insulation Company.

TOO GOOD TO SUPPRESS.

The A. A. Griffin Iron Company, through its Western agents, Charles C. Moore & Co., is distributing a neat bronchure, pointing out the advantages to be derived from the use of Bundy return steam traps connected on boilers, by means of which, the necessity for running feed pumps is avoided. In the Bundy trap, the waters of condensation, by their own weight, furnish the valve operating power, for when the water in the pear-shaped bowl over-balances the weight of the ball, the bowl settles down into the frame, thereby opening the valve in the live steam connection from top of boiler or dome to trap, which equalizes the pressure on both trap and boiler, when the water, of its own weight, discharges into the boiler.

The conviction comes from reading the booklet, that the Bundy steam trap is too good a thing to suppress.

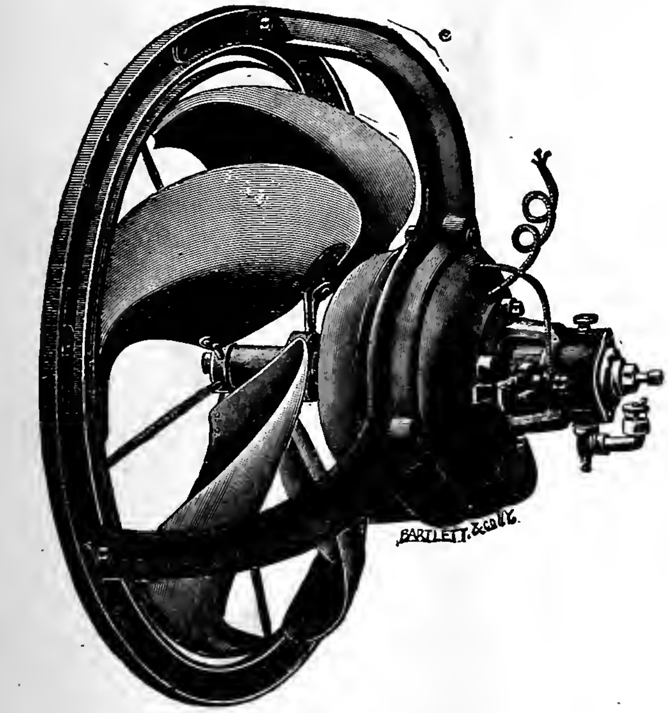
The Ferré Elastic Paint Company promises to make an interesting display of its new insulating paints and compounds during the Mechanic's Fair, soon to be held at San Francisco.

THE LAY PRESS.

POPULAR REFLECTIONS OF THE CONDITION AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

Plumas [County] has hundreds of ledges and plenty of ore easily extracted, at points where steam or water power for mining or milling purposes would be very expensive, possibly rendering the working of such ledges impracticable, but which are at such distance from streams capable of furnishing ample water power for large electric plants, that, by means of wires varying in length from one-half mile to five miles, electric power could be transmitted up out of canyons, over mountains and to any point desired. By means of such power, at once cheap and convenient, many of our low grade propositions, from $2 to $5 per ton, could be operated at a handsome profit. In fact, to work such mines successfully, cheap and reliable power is the great desideratum.

Just below Spanish Creek bridge, about five miles north of Quincy, is a most favorable point for the erection of an electric



THE LUNDELL EXHAUST FAN.

plant. Practically an unlimited amount of free water could be obtained, and, with a small expenditure, a pressure of from 70 to 100 feet easily secured. Within three miles of that point, are numerous quartz ledges carrying free gold. Some prospect as high as $8 to $10 per ton, but most of them from $2 to $5 per ton. If cheap and convenient power were supplied, all these properties would be developed and worked at a profit. Among the mines within range of such an electric plant may be mentioned the Bell, the Butterfly, the Kellogg, the Wormley, the Lee & Blakesley, the Orr, the Golden Gate, etc. Electric power from this plant would be of especial value in working the Elizabethtown channel claims from which, at points where operated, such quantities of large gold nuggets have been taken. This plant could also be utilized in furnishing electric lights to the town of Quincy—an item of no small interest.

The figures we have quoted and the facts mentioned as to location of plant and the mines within range of it, all point out a grand opportunity for capital seeking profitable investment. The venture, from the start, would be a paying one.—Quincy (Cal.) Bulletin, June 20th.

The whole State has cause to rejoice over the completion and transfer to it of the immense electrical plant at Folsom. The history of this great undertaking has been repeatedly published and is familiar to all. The State is now in possession of one of the greatest plants in the world for the generation of electricity, but of far greater value than that bare consideration is the fact that to the extent of its applicability it is a complete solution of the fuel problem, which always has been a drawback to the State.

The principle represented in the Folsom plant is the utilization of the power held by the perennial streams that flow down into the great valleys of the State from the Sierra Nevada. Thus the waters of the American River, which is only one of a vast number of these streams, are held by a dam and made to run electrical generators. At present the application of this enormous power is confined to Folsom, the Folsom prison and the city of Sacramento, but this is only a beginning, both of the use of electricity generated by this plant and of the utilization of the power held by the Sierra streams.

The advent of this power is particularly welcome just now when the natural disadvantages under which we labor on the score of expensive coal is aggravated by the formation of a combination for advancing its price. The Folsom plant is to be operated at a cost which represents but a fraction of the expense of coal required to generate an equal power. This matter has not yet been determined, but it soon will be, and we are confident that the revelation which it will make will be one of the strongest of conceivable incentives for pushing forward on new lines of enterprise and development that will produce a complete revolution in some of the most important concerns of our people.—San Francisco Call, July 13th.

The new era opening for Sacramento by the installation and successful working of the plant for the electric transmission of power from Folsom is one upon which the whole State can congratulate itself. If Sacramento can make use of the great power from a mountain river other cities can do the same thing. Every stream in California can be harnessed and a brilliant row of manufacturing cities will spring up along the whole length of the foothills of she Sierras.

Meanwhile Sacramento, as the pioneer in this part of the State, deserves the praise of all who are interested in the development of California. She has something now that is better than the Capitol, and something that no constitutional amendment can take away. The fuel question is solved, and with cheap power Sacramento ought to become a center of manufactures. It should be an ideal manufacturing place, too, with none of the smoke, grime and cinders of the coal-burning purgatories, but with fresh, clean, airy factories, in which the whirring electric motors will be attended by cheerful operatives, and where industry will not spoil the clear atmosphere for residence. We welcome the new Sacramento and wish it every success.—San Francisco Examiner, July 14th.

To communities that witnessed the successful introduction of the trolley system in the West years ago, and who have had long lines of city and suburban electric roads in practical operation so far back that a younger generation has come upon earth and the trolley system is regarded in the light of a back number, it is amusing to read in the columns of the Philadelphia papers articles descriptive of the "new system" and the wonderful revolution it is creating in supplanting the "horse cars," and bringing the suburban districts into town. Over a hundred years ago Franklin gave the Philadelphians the key to lightning, but they were slow to catch on, and the word became obsolete in that ancient place. Seattle could give those people some pointers on trolleys. A Western city that can burn up a trolley system at 1 a. m. and have it in active operation at 8 a. m., can teach Philadelphia some things in the way of modern progress that would convulse Benjamin in his grave, and make even the "horse cars" laugh.—Seattle (Wash.) Past-Intelligence, June 25th.

The figures given in yesterday's Argus, showing the amazing waste of money that has resulted from municipal ownership of the electric light plant, ought to interest every tax-payer. One of the reasons that taxes are high is because the city runs an electric plant. In eight years one hundred thousand dollars have been absolutely thrown away—absolutely, without question, for the lights could have been purchased of private parties for the excess beyond that amount. That excess would have been upwards of $8000 a year, and any private company would scramble for a contract to light Alameda for $8000 a year. Why cannot a common sense view be taken of the matter now? We have certainly had experience enough.—Alameda (Cal.) Argus, June 26th.

An electric railroad connecting the principal towns and cities of Southern California is a feasible project. Such a railroad would monopolize the passenger traffic because it could transport passengers as quickly and more cheaply than the steam roads. Between Redlands and the sea there is enough power going to waste to operate a thousand miles of railway. An electric railway from Redlands to Los Angeles is a project that is already enlisting the attention of capital, and its consummation is only a matter of time. Such a road would pay were it in operation now.—Ontario (Cal.) Observer, June 10th.

It is worth noting that nearly all the predictions that electricians made ten years ago, have either been fulfilled, or are well on the way to such a result.—Oakland (Cal.) Tribune, June 29th.

On all sides Sacramento is now the recipient of congratulations as the pioneer city in this new scheme of low priced power and the utilization of water power to turn the wheels of industry through the agency of transmitted electrical energy. But we must keep in mind that these congratulations will be repeated for other cities and towns which secure similar advantages by similar means. Thus, within three months electrical power transmitted thirty-five miles will be introduced into Fresno, and that place will then boast of the longest distance of transmission in the world. * * * Interests are becoming fixed just now that have long been fluctuating. Next year and the next are to determine what are to be the large and prosperous centers in this State, and those cities and towns that are not to the forefront within that period will be likely to remain far in the rear for many years.—Sacramento (Cal.) Record-Union, July 15th.

The rapid development of electrical engineering bids fair to greatly aid California. Hitherto the water power of the State has been little used owing to the fact that in most localities where it exists it is practically unavailable by the old methods, which required its utilization on the spot, or by which its distant employment was made extremely costly. In some instances water was carried several miles in pipes or ditches, for the purpose of operating water wheels, but this manner of utilization restricted its employment within comparatively narrow limits, and could only be adopted where the power was applied at an altitude lower than that of the source of the water. * * * Now, however, the electrical works at Folsom, on the American River, are partially in operation, and are supplying a thousand horse-power. * * * Like utilization of water power for long-distance transmission of electricity will eventually be made on the Upper Sacramento, the Feather, Yuba, Bear, Mokelumne, Russian and other rivers. It is well within the limits of possibility that electric power shall some day be brought to this city from the streams of the Sierra or the Coast Range, and it would seem that with such an unlimited power at command, and at trifling cost, the development of manufacturing in the district thus favored should go forward rapidly.—San Francisco News-Letter, June 6th.

News of the Month.

LITIGATION.

BALLARD, WASH.—The Mayor has received a summons from George F. Gund in a suit for $6200 against the city for breach of contract in the purchase of an electric light system.

TACOMA, WASH.—Efforts are being made to compromise the $1,000,000 suit brought against the Tacoma Light and Water Company by the city to recover the money paid the company for the plant now held by the city.

SEATTLE, WASH —Federal Judge Hanford has set aside a verdict which Howard Baker secured against the Western Union Telegraph Company for $6000 because of an error made in a cablegram in making h s name appear "Barker," on the ground that the damages awarded are excessive. The matter will now undoubtedly be compromised.

LOS ANGELES, CAL.—Western Union Telegraph Company has filed a complaint in equity against the Los Angeles Lighting Company foran injunction to restrain the defendant from putting up a line of poles and erecting electric wires thereon in line with the pole lines of the plaintiff on Second and Alameda streets. The telegraph company avers that induction would so distort the signals on the duplex and quadruplex instruments as to render their signals liable to serious interference.

COMMUNICATION.

OAKLAND, CAL.—The City Council has advertised for bids for a telegraph and telephone franchise.

JACKSONVILLE, OR.—The new telephone line between here and Crescent City, Cal., has been completed.

PORTLAND, OR.—The Columbia Telephone Company is busily erecting poles for its new system in this city.

SAN FRANCISCO.—The Pacific Telephone and Telegraph Company is placing its wires underground in the Mission.

PRESCOTT, ARIZ —Work is being prosecuted on a telephone line to Chaparrel via Lynx Creek Camp. Lines are also to be built to Jerome and all important mining camps in the country.

SAN FRANCISCO.—The Sunset Telephone and Telegraph Company has purchased 100 cells of chloride battery for operating "Express" systems of telephone exchanges in various cities of the Coast.

SAN JOSE, CAL.—The Council has adopted a resolution that it is the intention to grant a franchise authorizing the construction of a telephone and telegraph system, and inviting proposals for the same.

SPOKANE, WASH.—The Spokane Terminal Railway has been incorporated, and under its articles it has authority to maintain telegraph and telephone lines or contract with telephone companies for the construction and maintenance of such lines.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company and the Salt Lake and Ogden Gas and Electric Light Company have consummated an agreement by which both companies will utilize the same poles whenever possible.

SAN JOSE, CAL.—The California Telephone and Construction Company, by its Secretary, Walter M. Field, has applied for a telephone franchise. The petition states that the Columbia Telephone and the Smith system are to be used and the company has 400 subscribers.

HELENA, MONT —The Rocky Mountain Bell Telephone Company has practically completed its long distance line between this city and Great Falls, a distance of about 100 miles. New lines have also been erected between Helena and Butte, and between Butte and Basin.

WALLA WALLA, WASH.—The offices of the train dispatchers on the Washington division of the O. R. & N. Company have been moved from Walla Walla to Starbuck. At present, under W. E. Borden as chief, the office handles all trains between Pendleton and Umatilla and Spokane, and branches from Walla Walla, and also transact all the telegraph business pertaining to the Starbuck shops.

SACRAMENTO, CAL.—The Capital Telephone and Telegraph Company has practically completed the poling and wiring of this city for its new exchange, which will have a capacity of about 1,000 subscribers. Metallic circuits of No. 12 bare copper wire are used throughout, and the Columbia transmitter has been adopted. V. J. Mayo is electrician and E. Severance is manager of the Company.

SAN FRANCISCO, CAL.—Walter Francis Burns of the Standard Telephone Company of New York, states that his company has obtained the exclusive franchise for the placing of a system of long distance telephones in Japan. The first operations will be in the cities of Tokio and Yokohama, after which lines will be extended all over the empire. Mr. Burns sailed for Japan on July 23d, and was preceded by a number of men to be employed in the construction of the system.

ILLUMINATION.

CHICO, CAL.—H. H. Clark, of Santa Cruz, has been granted a franchise for an electric light plant.

LOS ANGELES, CAL.—E. E. Peck has been granted a franchise for an electric lighting, power and heating plant.

OROVILLE, CAL.—Max Marks has been granted an electric light and power franchise in this city and vicinity.

SAN FRANCISCO.—The Mutual Electric Light Company is laying redwood conduits throughout the business section of the city.

WATERLOO, OR.—An incandescent plant is to be placed in the woolen mills. Capacity, 300 lights.

BERKELEY, CAL.—The local electric light company has installed a new 200 h. p. Corliss engine.

PASADENA, CAL.—The Electric Light and Power Company has moved its offices to the Banning Block.

NAPA, CAL.—A 70-light incandescent plant is being installed by C. W. Fox in the woolen mill in East Napa.

PHŒNIX, ARIZ.—The Electric Light Company has ordered an additional 1,000-light General Electric generator.

HAMILTON, MONT.—It is expected that the new electric light plant will be completed during the present month.

WALLACE, IDAHO.—General M. C Moore has purchased an Edison 110-light dynamo to be used for an isolated plant.

SALT LAKE CITY, UTAH.—The Citizens' Electric Light Company are erecting their pole lines throughout the city.

NAPA, CAL.—L. Grothwell has been awarded a franchise for electric lighting privileges from the Asylum to Calistoga.

OLYMPIA, WASH.—The new State Capitol building will be equipped with an electric lighting plant and an electric elevator.

SALT LAKE, UTAH.—The Salt Lake Irrigation, Light and Power Company has been incorporated with W. P. Noble, President.

OROVILLE, CAL.—A 60-kilowatt Westinghouse alternator has been ordered by the Oroville Gas, Electric Light and Power Company.

South Bend, Wash.—Arrangements have been concluded by which C. S. D. Sale will continue to operate the electric light plant.

Alvarado, Cal.—A 20-kilowatt Siemens-Halske incandescent lighting dynamo and plant has been ordered for the Alvarado Sugar Refinery.

Eugene, Or.—The Board of Regents of the State University has concluded to light the University buildings and dormitory with gasoline gas.

Weaverville, Cal.—The Weaverville Electric Light Company has ordered two new dynamos, which will double the capacity of the plant.

Redlands, Cal.—The Light and Power Company is soon to extend its pole line from this city to the Asylum, a distance of about seven miles.

Orange, Cal.—The Santa Ana Gas an l Electric Light Company has asked for an exclusive franchise over all streets for electric lighting purposes.

Redlands, Cal.—The Redlands Light and Power Company has secured the contract for the electric lighting in the Highlands Asylum at $375 per month.

San Leandro, Cal.—The matter of installing a municipal electric lighting plant has been referred to Trustees Eber, Cary and Downie for consideration.

Spokane, Wash.—The Consumers' Light and Power Company, by Simon Oppenheimer, President, has received an electric lighting and power franchise.

Quincy, Cal.—Dr. R. Heidrich and F. Gausner, of San Jose, are conferring with Judge Goodwin regarding the advisability of putting in an electric light and power plant.

Ferndale, Cal.—An electric light plant is desired here, and Oluff Andreason has made a liberal offer to operate the same. The plant complete would cost less than $5,000.

Antioch, Cal.—The Ledger states that C. M. Belshaw is seriously considering the proposition of putting in an electric light plant in connection with the water works.

South San Francisco.—Miller & Lux have ordered a 150-light 110-volt chloride battery to supplement the incandescent lighting plant of their cold storage warehouses.

San Francisco.—The local papers announce that the electric light and power plant proposed to be placed by the San Francisco Gas Light Company, will be driven by gas engines.

Jackson, Cal.—B. E. Letang, of the Jackson Gas Works, has fully decided to put up an electric light plant this Fall and have it in running order by the beginning of winter.

Alameda, Cal—The city has accepted the arc and incandescent dynamos purchased from the Westinghouse Electric & Manufacturing Company, and has cancelled the bonds given.

Los Angeles, Cal.—W. L. Richardson has applied for an electric light and power franchise, and the Board of Supervisors has advertised for bids for same to be received until August 7th.

San Francisco.—E. C. Jones, engineer for the San Francisco Gas Light Company, read a paper illustrated by practical experiments, on "Calcium Carbide," before the last meeting of the Academy of Sciences.

Phœnix, Ariz.—The Phœnix Electric Light and Fuel Company has received and is erecting a 1,500-light monocyclic generator and two new boilers, having a capacity of 250 h. p. to supplement its present plant.

Salt Lake City, Utah.—All machinery for the power house and the supplies necessary for the construction of the new plant of the Citizens' Electric Light Company, have been shipped from the East.

San Francisco, Cal.—The new Cliff House, now being erected on the site of the old Cliff House, is being wired with the conduit system, using the flexible tubing of the American Circular Loom Company.

San Francisco.—Fifty-eight 1,000-ampere-hour chloride accumulator cells are to be placed in the Safe Deposit building. Regulation will be effected by the "booster" system of the Electric Storage Battery Company.

San Jose, Cal.—The San Jose Light and Power Company, at the annual meeting of stockholders on June 21st, elected C. W. Quilty, President; Uriah Wood, Vice-President; W.W. Gillespie, Secretary; and C. T. Ryland, Treasurer.

San Francisco.—Bids have been received for the electric wiring of the Parrott building for 4,000 incandescent and 400 arc lamps. The lowest bid received was that of E. H. Forst for $32,-964, and to whom the contract was awarded.

San Rafael, Cal.—The Electrical Construction and Repair Company, of San Francisco, has built the pole line from this city to Mill Valley, and will connect up all Mill Valley circuits thereto for the San Rafael Gas and Electric Light Company.

Logan, Utah—The Hercules Power Company has completed its dam across the Logan River in Logan Canyon, and it is said will soon purchase turbines and electrical machinery for transmitting light and power to this city and surrounding towns.

Ventura, Cal.—The people of Ventura have voted for the issuance of $130,000 bonds, of which $106,500 is for the purchase of the Santa Ana Water Works and $23,500 is for the purchase of the arc light system of the Ventura Land and Power Company.

Seattle, Wash.—The Third Street and Suburban Company has erected a power house adjoining that of the Seattle Steam, Heat and Power Company, on West street, in which are placed the dynamos for operating the lighting circuits of the Company.

Tacoma, Wash.—Mayor Orr has vetoed the ordinance proposing to reduce the price of gas as sold by the Tacoma Gas and Electric Company, on the ground that the present rates of $2 a thousand for lighting purposes and $1.75 for heating purposes are reasonable.

Santa Cruz, Cal.—The Santa Cruz Electric Light and Power Company is driving a 1,000-light alternator by means of an Otto gas engine. The plant is operating satisfactorily, and two more similar double cylinder gas engines will probably soon be placed, displacing the use of steam.

San Francisco, Cal.—The Park Commissioners, in response to many imperative demands, are considering ways and means for lighting the park drives. It is probable that material assistance towards defraying the cost will be received from bicycling clubs and livery stable people.

Spokane, Wash.—The County Commissioners have abandoned the idea of erecting an isolated electric lighting plant in the new Court House, the reason assigned being that the current can be bought from central stations more cheaply than it can be produced in an isolated plant.

Prescott, Ariz.—The Prescott Electric Light Company has been incorporated with a capital stock of $100,000. President and Treasurer, Frank L. Wright; General Manager, J. D. Moore; Secretary, F. A. Cole; who, with R. H. Burmister and William E. Hazeltine, constitute the Board of Directors.

San Jose, Cal.—The Electric Improvement Company has concluded to meet the competition of the San Jose Light and Power Company at all points, and is therefore engaged in laying mains preparatory to the erection of a gas plant. It is probable that a hard gas war will follow the electric light war that has waged sc long between these companies.

Leadville, Col.—Some of the stockholders of the Denver Consolidated Electric Company, among whom are E. W. Rollins, Jonn Poole and Colonel Goddell, have organized a light and power company here. The plant will be operated by water power, or will use some multi-phase system. C. E. Doolittle has been engaged to superintend the designing and construction of the plant.

Oakland, Cal.—The stockholders of the Oakland Gas, Light and Heat Company, at their annual meeting held on August 5th, unanimously re-elected the old Board of Directors, consisting of Joseph P. Eastland, John W. Coleman, D E. Martin, John T. Wright and James Moffitt. Mr. Eastland was elected President, Mr. Coleman Vice-President, and John A. Britton Secretary and Treasurer.

Phœnix, Ariz.—The Phœnix Light and Fuel Company and the East End Electric Light Company, known as the Gardiner plant, have effected a combination to go into effect on August 18th. The Gardiner plant will be removed to the works of the other Company on First avenue and an advance in rates will undoubtedly result, as competition has been such that the Companies have heretofore been operating at a loss.

San Francisco, Cal.—The Edison Light and Power Company, at its fourth annual meeting, held July 15th, elected J. B. Stetson, W. F. Whittier, W. E. Brown, Gustav Sutro, L. P. Drexler, C. E. Green and John J. Valentine as Directors, after which the Directors elected the following officers: President, J. B. Stetson: Vice-President, W. Brown; J. E. Green, Secretary and Manager; William Angus, Assistant Secretary; R. J. Davis, Assistant Manager.

TRANSPORTATION.

Saratoga, Wyo.—An electric railway is projected between this place and Walcott, a distance of twenty-two miles.

Salem, Or.—The Davidson Park branch line of the Salem Motor Company has been completed and is in operation.

Whittier, Cal.—The sum of $7050 has been subscribed towards building an electric railway in this place and vicinity.

Seattle, Wash.—David Bruce has been appointed Superintendent of the Union Trunk lines vice E. B. Hussey, resigned.

Antioch, Cal.—C. M. Belshaw is considering the advisability of constructing an electric railway here.

Phœnix, Ariz.—The Phœnix Electric Railway Company has purchased an additional 25 h. p. Westinghouse railway equipment.

San Pedro, Cal.—A ship-load of cedar poles for the Los Angeles and Santa Monica Electric Road has arrived from Everett, Wash.

Seattle, Wash.—Fifteen "G. E. 800" railway equipments have been ordered by the Seattle Consolidated Street Railway Company.

Galt, Cal.—The work of grading for the electric road between Stockton and Lodi is progressing rapidly, and the road will be completed within twelve weeks.

Seattle, Wash.—Sixty-seven miles of street-car lines, both electric and cable, are used by the Postoffice Department in this city for the transportation of mail.

San Diego, Cal.—It is reported that George Kerper, owner of the property of the cable road, proposes to start up the line after having equipped it with the trolley.

Seattle, Wash.—The Seattle Consolidated Street Railway Company has decided to build a fire-proof station and car barn on the site of the station recently burned.

Seattle, Wash.—F. L. Dame has resigned the general managership of the Consolidated Street Railway Company and S. L. Shuffleton has been appointed his successor.

San Francisco.—Orders have been issued to conductors of the Market-street Railway Company's system to issue transfers to parallel lines of the Company in case of stoppage.

San Francisco, Cal.—The trolley will soon supplant the cable on the Ellis street line of the Market-street Railway Company, and the cable road on Oak street will be the next to go.

Hermosillo, Mexico.—It is believed that the Government of Mexico has granted H. T. Richards a concession to build a street railway here, to be operated by horses or electricity.

San Francisco, Cal.—Four bids have been received for the power plant for the Sutro-street Railway, and it is said that the road will be in operation to the Sutro Baths by October 1st.

Tacoma, Wash.—The power house for the Fern Hill and Puyallup branch of the Tacoma Traction Company is completed and is now operating all cars on the Edison and Puyallup lines.

Los Angeles, Cal.—The Los Angeles Railway Company, owning forty-seven miles of street railroad, proposes to reorganize its system, and will undoubtedly change its cable lines to electric.

Galt, Cal.—The Gazette is of the opinion that the people of Galt should reach out and offer some inducement for the introduction of the electric power and electric transportation for their town.

San Francisco, Cal.—The Market-street Railway Company has obtained a franchise for the construction of an electric line through Sunnyside, Corbett and Ocean avenues to the new race-track.

San Francisco, Cal.—The Market-street Railway Company is to equip the horse car line at present running on Tenth street and Potrero avenue to the Potrero and South San Francisco with the trolley.

Tacoma, Wash.—The City Park Railway Company will build a 2000-foot extension into Point Defiance Park at once, as all papers with the Park Commissioners have been signed and the contracts awarded.

Seattle, Wash.—Two cars on the West Street and North End Electric Railway, running between this city and Ballard, have been running as scheduled for months with a daily mileage of 225 mileage each.

Boise City, Idaho.—The Boise Rapid Transit Company enjoys the distinction of being an electric railway company that is able to run a power house and operate a single car, and yet make satisfactory dividends.

Oakland, Cal.—The Oakland Consolidated Street Railway Company has contracted with the Walker Electric Manufacturing Company for the purchase of a 400-kilowatt Walker railway generator, to be driven by rope transmission.

St. Helena, Cal.—A franchise for the construction of an electric railway along Main street, and for the erection and operation of telephone, telegraph and electric light lines will be sold on August 13th.

Shanghai, China.—L. S. J. Hunt, formerly owner of the Post-Intelligencer of Seattle, has secured from the Shanghai Council the right to construct an electric street car system at a cost of $2,000,000 in gold.

Sacramento, Cal.—L. T. Hatfield has been awarded a franchise to construct and operate an electric railway on V street, which is believed to be for the recently organized Sacramento, Fairoaks and Orangevale Electric Railway Company.

Portland, Or.—The Vancouver cars are running through from the intersection of Second and Washington streets, Portland, to the Vancouver ferry landing on the Columbia River, enabling passengers to make the entire trip for one fare.

San Francisco.—C. M. Bridges is exhibiting a model of an underground conduit electric railway system in the History Building, in which the working equivalent of the trolley wire is on the car, while the equivalent of the trolley is in the conduit.

San Francisco, Cal.—The Sutter-street Railroad Company has decided to extend its Pacific avenue line by building an electric road out Pacific avenue from the terminus of the cable line at Devisadero street to Walnut street through Richmond to the Park.

Los Angeles, Cal.—Notice of sale of franchise has been published for an electric railway to run from the intersection of Freeman street with Bush street, thence southwesterly on Bush street to Hoover, thence south on Hoover street to Forrester avenue. Bids must be in by August 19th.

Oakland, Cal.—The Southern Pacific Company is waging a hot fight against the Oakland, San Leandro and Haywards Electric Railway Company since the latter has established an express service for the carrying of parcels, etc., between San Francisco, Haywards and the way towns along the line.

Sacramento, Cal.—The Sacramento, Fairoaks and Orangevale Electric Railway has been organized to build a line, preferably along the north bank of the American River from Orangevale and Folsom to this city. The road will undoubtedly be operated by power from the plant of the Electric Power and Light Company.

Santa Barbara, Cal.—The Santa Barbara Consolidated Electric Company, proposing to construct, acquire, operate and maintain electric railways in the county of Santa Barbara, has been incorporated with a capital stock of $200,000, of which $40,000 is subscribed. Its President is S. J. Keese, a well-known electrical engineer of Los Angeles.

San Francisco, Cal.—The Market-street Railway Company has commenced work on its new electric power house to be erected on the corner of Bryant and Alameda streets. When finished, it will be the largest electric plant in the country, and will be used to drive all the electric street-car lines belonging to the Market-street system. The power-house of the Metropolitan Railroad will then be abandoned.

Iron Mountain, Cal.—The Iron Mountain Railway Company, of Shasta County, has been incorporated with Alfred Fellows and Charles W. Fielding, of England, and L. B. Parrott, C. O. Eels and M. M. O'Shaugnessy as Directors. The Company proposes to build a steam or electric railroad from the Iron Mountain Mine to the Spring Creek crossing, on the California and Oregon Railroad, a distance of 12½ miles, thence to Popley Station.

Tacoma, Wash.—A bill of sale has been filed conveying the property of the Point Defiance-street Railway Company to the City Park Railway Company for $163,000. Shortly after the sale the City Park Railway Company filed a mortgage on the property for $163,000 to S. Z. Mitchell at six per cent. per annum, one note being for $13,000, and thirty for $5,000 each, all of them payable on demand at the office of the Old Colony Trust Company, of Boston.

Los Angeles, Cal.—The new electric system of the Los Angeles Traction Company will be in operation by September 1st. The road is being constructed in a substantial manner with sixty-pound rails, the overhead wiring, etc., is completed, and the entire equipment will be modern. The road is to run from the Santa Fe depot to Hoover street, the line of construction being as follows: From the depot up Third to Hill, to Eighth, to Pearl, to Eleventh, to Bush, to Hoover.

San Francisco, Cal.—Contracts for equipments for the Sutro Electric Railroad have been awarded as follows: To the Westinghouse Electric and Manufacturing Company, 6, type 12A 25 h. p. equipments; to the Walker Manufacturing Company, fifteen 25 h. p. equipments; to the General Electric Company six "G. E. 800" equipments, also one 400-kilowatt, and one 200-kilowatt railway generators, to be direct connected to Fulton Iron Works engines.

LOS ANGELES, CAL.—Most of the material for the extension of the Pasadena and Pacific Electric Railway, from this city to Santa Monica, is on the ground, and the work of construction will begin about September 1st, or as soon as the right-of-way and franchise matters can be settled. The extension will be eighteen miles long and double-tracked throughout. Two dynamos for the Santa Monica division are here. They have a capacity of 350 and 450 h. p. respectively. Oil is to be used as fuel.

LOS ANGELES, CAL.—Articles of incorporation have been filed by the Commonwealth Trust Company of Los Angeles county, formed for the purpose of obtaining rights of way, subscriptions, donations, etc., for the construction of a railway from Victor to Hesperia, San Bernardino county, through Antelope Valley and Tejon Pass, Kern county, to Bakersfield, to be operated by steam or electricity. The directors are T. W. Haskins, C. M. Wells, Nathan Cole, Jr., E. S. Mead, A. C. Sprague, C. A. Richey and S. C. Wilcox.

AUBURN, CAL.—Messrs. Hartley & Reynolds, well-known mining men, have applied for an electric street railway franchise to be built on the main thoroughfare from the station to lower Auburn. The projectors intend to have the road in operation by next winter, and whenever business will justify, will extend the line. Power will probably be purchased from the Ball Electric Light Company, and the accepted franchise calls for the completion of the road within one year.

SAN FRANCISCO, CAL.—The Presidio and Ferries Railway Company, operating a horse car line from the ferries to the intersection of Montgomery avenue and Montgomery street, and a cable road thence via Montgomery avenue and Union street to the Presidio, is to reconstruct its road-bed, and equip the line as an electric railway. This is one of the most hilly railways in the city, encountering grades as high as 18½ per cent., but excessive grades will be equipped with auxiliary cables.

SAN FRANCISCO, CAL.—The Washburn Moen Manufacturing Company has acquired the business and plant of the California Wire Works, will hereafter operate the same in conjunction with their factories at Worcester, Mass., and Waukegan, Ill. With the fine rope and cable machinery and trained mechanics of the California Wire Works they claim to be prepared to manufacture and promptly supply the strongest and most serviceable wire rope and cables made in the world.

SEATTLE, WASH.—The franchise of the Consolidated Street Railway Company has been renewed, with several modifications, principal among which are that from the years 1900 to 1909 inclusive, the company is to pay the city 1 per cent. of the gross receipts, and from 1910 to 1944 inclusive, the company is to pay 2 per cent. The new franchise requires also that when the city shall have a population of 125,000, the company shall be required to issue transfers to cross lines, and to accept tickets from such cross lines.

HAYWARDS, CAL.—E. P. Vandercook has been granted a franchise for an electric road from Oakland to Livermore. The proposed road is to start from Lynde street and Peralta avenue, Oakland, and will strike San Leandro; thence along the county road from San Leandro by the way of Lake Chabot to Castro Valley, following said road to its intersection with the road from Haywards to Moraga Valley; thence along said road to the Haywards and Dublin road to the town of Dublin, and from there to the town of Livermore.

SAN FRANCISCO, CAL.—The State Railroad Commission, acting under a decision of the Attorney General to the effect that all roads, whether steam or electric, carrying freight must report to the Railroad Commission, has ordered the San Francisco and San Mateo Electric Railway Company to report to it, because the road owns and operates a funeral car, and carries bodies to the Holy Cross Cemetery for interment. The road has refused to report as ordered, and the lawyers are trying to decide whether a hauling dead body is freight or passenger traffic.

SAN FRANCISCO.—The first two units of the eight 400-kilowatt Siemens-Halske generators for the Market-street Railway Company will be in operation by the middle of August. When completed the plant will consist of four vertical triple expansion Union Iron Works engines, running at 145 revolutions per minute at an initial pressure of 175 pounds of steam, each engine being direct connected to two 400-kilowatt dynamos. The Union Iron Works is installing 5,000 horse-power of water tube boilers of its own manufacture in the Bryant-street power house.

TACOMA, WASH.—Postmaster Case has rendered a report to the Postoffice Department in regard to mail service on electric roads in this city. The report shows that the following lines are used: Tacoma Railway and Motor Company, city lines 34.80 miles, carrier service to Steilacoom, 13.25 miles, mail contract; Tacoma Traction Company, to Midland, 9.38 miles, mail contract; Tacoma Traction Company, to Edison Junction, 5 miles, carrier service; City Park Railway, to Smelter, 7.60 miles, carrier service. The total number of miles used daily by the postal service is therefore 70.3 miles.

SAN FRANCISCO, CAL.—The West Shore Railroad Company has been incorporated for the purpose of constructing and operating a double or single track railroad by steam, electricity or other motive power, through San Mateo and Santa Cruz counties from San Francisco to Santa Cruz. The estimated length of the road is eighty miles, and the capital stock is $2,000,000, of which $88,000 has been subscribed. The Directors are C. M. Sanger, of San Leandro, Behrend Joost, of San Francisco, Robert S. Thornton, of Colma, John W. Eisenhuth, of San Francisco, and Louis Dunand, of San Rafael.

TRANSMISSION.

SALINAS, CAL.—A. L. Burbank has secured the right of way for water mains from the Arroyo Seco, the object being to secure water for King City and for the installation of an electric transmission plant.

BERUS BAY, JUNEAU, ALASKA.—The Berus Bay Mining and Milling Company has recently installed a 25-kilowat Edison Generator operating two 15 horse-power Edison double reduction railway motors used for hoisting.

CŒUR D'ALENE, IDAHO.—The Poorman, Tiger, Gem and Frisco Mines, which are the wealthiest mines in the State, are working up a plan to utilize the power of Thompson Falls for the operation of the mines in the Cœur d'Alene district.

BAKERSFIELD, CAL.—It is intended to run the Big Blue, the Joe Walker, Bright Star, the Keysville and any other mining property within a radius of fifty miles from the Kern County power plant by electricity, both for pumping and mining.

REDDING, CAL.—The English syndicate which recently purchased the Iron Mountain Mine is engaged in considerable development work, and will probably erect a reduction mill near Copley to be run by electric power transmitted from a neighboring spring.

YELLOW JACKET, IDAHO.—The water power of Yellow Jacket Creek is to be used to drive the mine and mill at this place. The transmission will be one mile, and experts have reported that these improvements will be necessary before the mine can start up with satisfactory results.

BODIE, CAL.—The Standard Consolidated Mining Company, which was the first to install a long distance electric transmission plant on the Pacific Coast, has increased its plant by the addition of a 100 h. p. General Electric generator for operating pumps, hoisting machinery, etc.

SEATTLE, WASH.—F. H. Osgood and E. H. Ammidown have announced that they are prepared to enter into a contract to deliver to the city any amount of water necessary from the Cedar River falls. This will deliver water into the city at high head, the utilization of which, for electric purposes, is being considered.

OROVILLE, CAL.—It is believed that the Golden Feather Mine, comprising about a mile of the Feather River bed, will be practically worked out this year, in view of which its owners are considering the advisability of utilizing the water power at the command of the mine for electric transmission purposes. Probably 5,000 horse-power can be developed.

LOS ANGELES, CAL.—The Journal states that a survey is being made at Tejunga for the development of water on a large scale by means of tunnels and percolating pipe, by people whose identity is kept secret. Already nearly $2000 has been expended on preliminary work, and the Los Angeles Railway Company has agreed to abandon its present steam plant and adopt power from the electric transmission, provided a saving of 5 per cent. will be effected thereby.

LOS ANGELES, CAL.—H. Hawgood, Consulting Engineer of the Kern River and Los Angeles Electric Power Company, has sent out a party, under F. H. Olmstead, to locate a route for the transmission line from the point where power is to be generated to this city, a distance of about 105 miles. The work of the surveying party will occupy about a month, and in the meantime work on the canal is progressing rapidly. From the report of W. D. Larrabee, C. E., it appears that 10,000 horse-power at 200 feet fall, or 50,000 horse-power at 1,000 feet fall, can readily be developed. It is expected to develop and transmit to Los Angeles 40,000 horse-power, which can be done at a cost of $125 per horse-power.

SALT LAKE CITY, UTAH.—Contracts have been closed in New York for the complete transmission plant of the Big Cottonwood Power Company. Four General Electric 400-kilowatt tri-phase generators are to be driven from Pelton water wheels, each generator being direct coupled to a Pelton wheel. The plant will be an innovation in that the wheel house will be moulded to and occupy the position on the dynamo base ordinarily held by the dynamo pulley, which at once makes a very compact installation. The Pelton wheels will be about four feet in diameter and will be driven at a head of 380 feet, water for the same being carried

partly in wood-stave pipe and partly in iron pipe. The total transmission will be for seventeen miles, at 10,000 volts, and the entire equipment has been ordered. The Big Cottonwood plant was conceived and promoted by R. M. Jones, the well-known hydraulic and electric engineer of this city.

Tulare, Cal.—All rights of way for the Keweah Electric Power Company have been secured.

Grass Valley, Cal—Eugene J. de Sabla has been appointed Superintendent of construction of the Nevada County Electric Power Company, with headquartes in this city.

Redlands, Cal.—President Baldwin of Pomona College has a force of men at work on his tunnel in Mill Creek, which is designed to develop power for an electric plant. The tunnel is now 300 feet deep.

Grass Valley, Cal.—The Gold Hill Mine will commence operations again as soon as electric power can be obtained from the Nevada County Electric Power Company, now under construction. The mine has long been idle because of the high price of fuel.

Ferndale, Cal.—Surveyors Shaw and Francis have reported adversely upon a proposition to utilize the water power of the Upper Bear River for transmission to this place, as the cost would be tyo great.

Jacksonville, Or.—The Klamath Falls Light and Water Company, recently incorporated for the purpose of erecting and operating an electric plant and water works, has purchased a site from E. R. Reames, and have contracted with the irrigation company to run their plant.

San Francisco.—The American Power and Tide Wheel Company has been incorporated for the purpose of securing and owning water rights; to construct and own reservoirs and canals; to erect, sell, own and use prime movers and power plants to be run by electricity, water, steam or other means. Directors, Chas. Boone, Marcus S. Love, A. H. St Marie, R. M. Clements, of this city, and D. E. Alexander, of Sacramento. Capital stock, $900,000.

Missoula, Mont.—The Board of Trade has adopted resolutions favorable to a proposition submitted by the Missoula General Electric Company for the damming of the Missoula River. Under this proposition the citizens of Missoula are to guarantee title and flowage rights to either the Heyfrow or Kroone ranch, with flowage rights, and to subscribe $15,000 to the first mortgage bonds of the Electric Company, which amount to $15,000. The city is to extend the light contract with the Company for a minimum of 31 lights, five years beyond the present contract period. If these conditions be fulfilled the Company agrees to build an 18-foot dam and power house by January 1st. The Company states that 500 horse-power will be developed for electric purposes. The dam will develop 3,000 horse-power at low water, of which 600 horse-power will be used for irrigating. $11,000 is already subscribed and the plan meets with general approval.

Bakersfield, Cal.—Specifications asking for bids have been issued by the Power Development Company, of San Francisco. The Company proposes to develop the water power existing at the mouth of the Kern river canyon, about fourteen miles northeast of Bakersfield, which will be used under a head of 190 feet, and furnish at least 10,000 horse-power. Some of the best capitalists in San Francisco control the Company and it is proposed to supply power to consumers at a price equivalent to what it would be if coal could be bought for $6 per ton. The present price of coal in Bakersfield is $13 per ton. The flume line is nearly completed, and on August 15th the contract will be let for the remainder of the construction work. A seventy-two inch steel pipe will be used to convey the water from the end of the long flume to the water-wheels in the power house. At first 1500 horse-power will be developed, and this will be gradually increaled from time to time to meet the demands for extra power. There are some valuable mines about thirty miles east of Bakersfield, that require about 1300 horse-power, and they will be accommodatod next summer.

San Francisco.—Satisfactory progress is being made by the Clear Lake Electric Company toward the utilization of the waste water power of Clear Lake, in Lake County, for delivering electric energy to San Francisco, Oakland, Benecia, Mare Island, Vallejo, Santa Rosa and other cities along the line. The investment necessary to develop the power may reach $3,000,000. Clear Lake has a surface area of eighty-two square miles and a catchment area of 517 square miles. Its average depth is forty feet and the average rainfall, as taken from different measurements and observations from 1867 to date, is 34.4 inches per annum, 50 per cent. of which for utilization would amount to 119,565 000.000 gallons per annum, or 327,000,000 gallons daily. By building a 27-foot dam across Cache Creek, the outlet of the lake at a point five miles below the lake, and by building 67,300 feet of 5-foot pipe line, a head of 424 feet of water will be obtained which will develop 28,950 horse power at the dynomos. Clear Lake lies at an elevation of 1317 feet, a distance of seventy-five miies due north of San Francisco, and the company hope to be able to sell power in San Francisco for $4.00 per horse power per month. Tne construction of an electric railway, to be known as the Clear Lake and Vaca Valley Railroad, from Clear Lake to Benecia is also contemplated.

MISCELLANEOUS.

San Francisco.—Union No. 6 of the National Brotherhood of Electrical Workers held their annual picnic at Schuetzen Park on July 14th.

Santa Barbara, Cal.—San Francisco parties have leased all the bituminous rights of the Alcatraz Asphalt Company, at Carpenteria and will sink oil wells.

Palouse, Wash.—The Palouse Mica Company has been incorporated by Charles Treavor Cross, John P. Duke and William Goodyear. Capital stock, $100,000.

San Diego, Cal.—Mayor Carlson has vetoed an ordinance imposing a ground rental of fifty cents per annum for each pole erected or used for electrical purposes.

San Francisco.—The illustrations which appeared in the Morning Call concerning the recent fiesta in Los Angeles, were transmitted from that city by the telautograph.

Bakersfield, Cal.—It is reported that Captain John Barker recently signed a contract with parties in San Francisco to bore for gas and oil at his place on Kern river, about six miles above here.

Anaconda, Mont.—E M. Talbot, foreman of the power house of the Anaconda Electric Light and Power Company, was instantly killed on July 7th by the bursting of a pulley on the main shaft.

Watsonville, Cal.—A committee of local firemen has advised the Board of Trustees to investigate and then adopt a new fire alarm system which Burbeck & Co. agreed to maintain for a monthly rental of $20.

Victoria, B. C.—William Sutton, a lumberman of Euculet District, Barclay Sound, is erecting a complete electric power transmission plant, to be driven by water power, to be used for transporting logs from timber land to water. The electric motors will displace the use of teams or horses and portable steam engines.

Seattle, Wash.—In revenge for a fancied grievance, a miscreant crossed an arc and an alternating incandescent circuit with several strands of bell wire, the result of which, probably fifty telephones were burned out, together with a dozen or more fire alarm boxes, and the lighting service on the crossed circuits was interrupted for the night.

Los Angeles, Cal.—The oil producers of this city have organized by adopting a Constitution for the formation of an Oil Producers' Exchange, which will endeavor to put in pipe lines to the ocean, so that shipment can be made by water, thus widening the market. It is believed that by this means oil can be landed in San Francisco for $1.30 per barrel.

Tacoma, Wash.—An ordinance has been enacted establishing new rates of lighting service from the municipal plant and which reduces the old rates approximately as follows: All night arc lights, 20 per cent.; midnight arc lights, 37 per cent.; half arc lights, 30 per cent.; incandescent commercial lights, 50 per cent. The Board of Public Works claims this to be necessary because of alleged violations by the Commercial Electric Light Company of an agreement with the city to maintain the old ordinance rates, while the company denies this but claims that the introduction of the Welsbach business have cut into the city's business. A rate war is now being waged between the city and the company, and the Tacoma Gas and Electric Light Company has under consideration the bringing of a suit to enjoin the city from selling any lights at less than cost.

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The Folsom-Sacramento Power Transmission.

The utilization of the water-power of the American River was first conceived by the late Horatio Gates Livermore, one of the pioneers of the State, who in the early '60s was engaged in the logging industry. The famous Georgetown Divide, in which the first discovery of gold in California was made, is situated in El Dorado County, between the Middle and the South Forks of the American River. It is a district that is exceedingly mountainous, and is heavily timbered with sugar and yellow pines of unsurpassed quality, and while floating logs down the American River from this district the necessity for securing a still water basin for locating log booms to receive the logs became impressed upon the mind of Mr. Livermore, who, in 1866, as President of the Natoma Water and Mining Company, laid the foundations for the present dam. The various forks of the American River rise in the Sierra Nevada Mountains within a few miles of Lake Tahoe, and the supply of the river is peculiar in that the catchment is derived from new sources at all seasons of the year. The period usual elsewhere as the "dry season" is bridged over by the melting of snows in the mountains, and so deep is the snow in some of these regions that the country can be worked or even explored only during a few months in the year. In the fall, when the snows have about disappeared, the rainy season sets in replenishing the waning supply from melted snows, and thus, between the rains of winter and the melting snows of summer, the water supply has never been known to fail. Practically all of the catchment area is, moreover, of granite formation, surfaced with soil of varying depths, and its hundreds of deep ravines form natural sites for the building of impounding reservoirs for increasing the water supply to enormous proportions. In fact, it has been determined from carefully made surveys that an expenditure of less than twenty-five dollars per horse-power in the construction of such impounding reservoirs will permanently increase the flow of the river at Folsom to such an extent that its minimum flow, after these improvements have been carried out, will exceed its present maximum flow. A conservative estimate of the possible power that can be developed by this means at Folsom is a minimum of 15,000 horse-power.

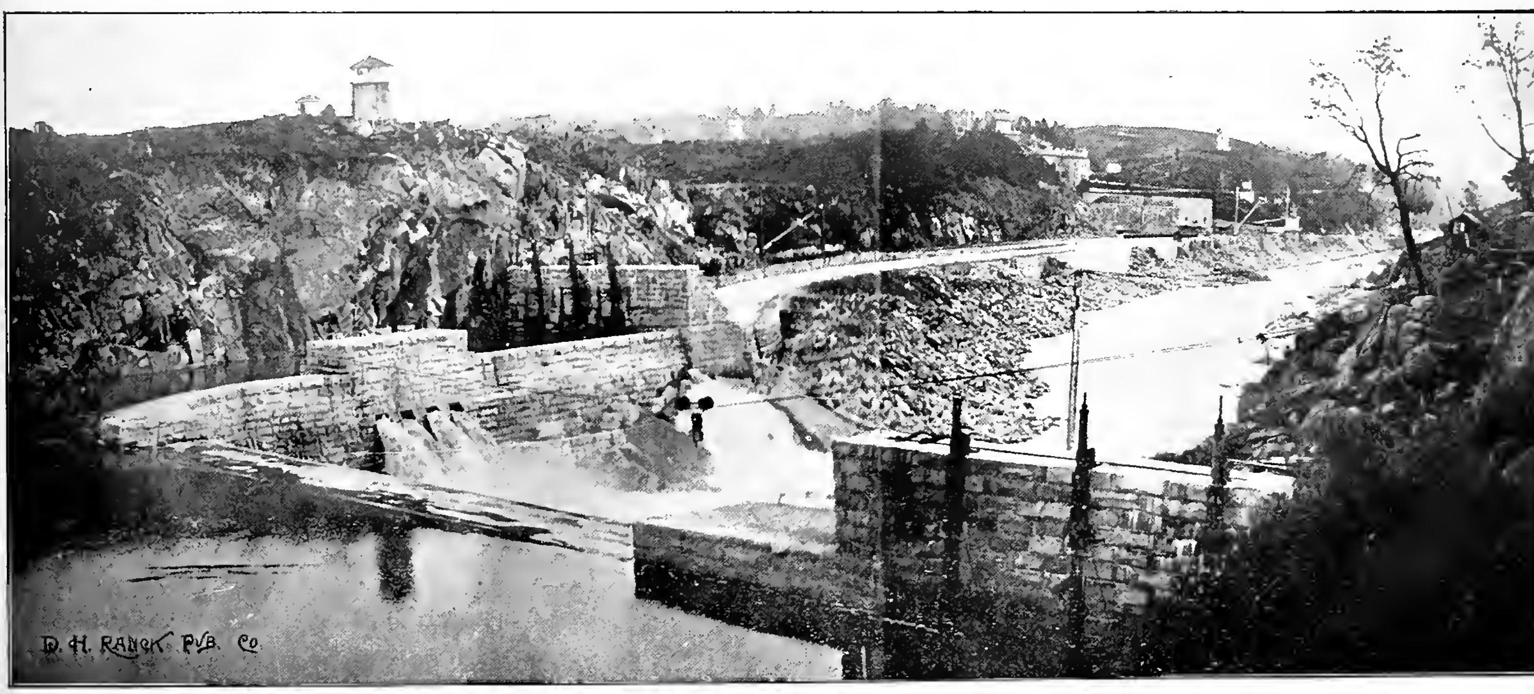


FIGURE 1.—THE DAM AND HEAD WORKS OF THE FOLSOM WATER POWER COMPANY, SHOWING SECTION 1 OF THE EAST CANAL. LOOKING DOWN THE AMERICAN RIVER.

The Folsom Water Power Company, which consists of H. P. and C. E. Livermore, Albert Gallatin, A. J. Ralston, and others, succeeded to all the rights of the

Natoma Water and Mining Company in 1881, up to which time the foundations of the dam had been laid in solid granite masonry, but so much capital was required to build a dam of sufficient solidity to withstand the enormous pressures, that, in the early part of 1888, a contract was entered into with the State of California, whereby the State in return for ample concessions agreed to furnish to the Folsom Water Power Company such convict labor as was necessary to enlarge and finish the company's dam, and to finish Sections 1 and 2 of the proposed canal to the termination of Section 2 at Robbers' Ravine, near the town of Folsom.

The nature of the site of the dam is clearly indicated in the accompanying illustrations. High granite bluffs confine the river on either side for many miles, and where the dam is erected they form a natural point for the building of such a structure. The dam has an elevation of 210 feet above sea level, and of 175 feet above Sacramento. It contains more than 37,000 cubic yards of masonry, while the contents of the head works is about 15,000 cubic yards. The general dimensions of the dam are shown in Figure 5, from which it will be seen that the crest is provided with a heavy wooden shutter, 180 feet in length, which can be raised during the low-water season in September by five hydraulic rams, so as to create a storage basin for conserving the flow during the hours of light load when the least amount of water is used. The basin formed when the shutter is raised backs up the water in the river for a distance of about four miles, causing an estimated storage of 13,007,105 cubic yards of water. The shutter is a trussed timber platform, resting in a masonry recess running longitudinally along the top of the center of the dam. When raised, the platform is made tight at the ends by wedge pieces, and at the bottom by mud apron boards. When lowered into the recess it is flat and secure from damage by trees and logs which may pass over it. Three of the five hydraulic rams operating the shutter are seven inches in diameter each, the remaining two having a diameter of five and one-half inches each, all having a stroke of five feet six inches each. The details of the larger rams will illustrate the construction of the smaller ones as well. The cylinders are seven and one-half feet in length, with an external diameter of eleven inches, and each has two trunnions on which it is free to oscillate. One of these trunnions is solid, while the other is bored with a half-inch hole to receive the pressure water by which the apparatus is operated. The bottom of the cylinder has a hemispherical cap secured to it by eight, one and one-fourth inch bolts, while at the other end there is a brass stuffing box through which the shank of the piston passes. The piston is six inches in diameter and seven feet eight and one-half inches long, and the piston head is a hemispherical brass knob with a projecting screw, by which it is fastened to the piston. When the shutters have been raised the piston is fastened in position by means of a locking pin, moved back and forth by a pinion and hand wheel.

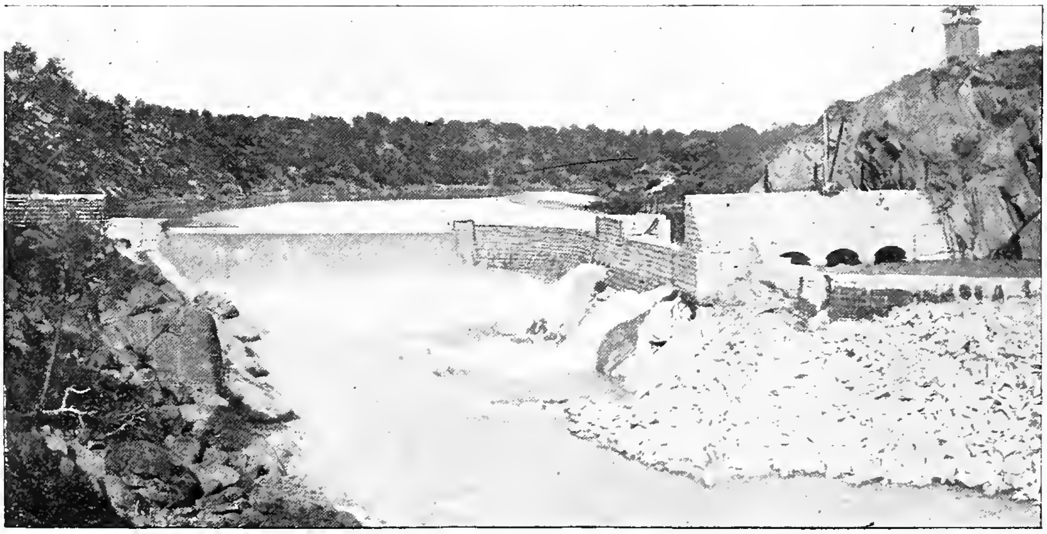


Figure 2.—The Dam and Head Gates of the Folsom Water Power Company, Looking up the American River.

This hydraulic method of operating the gates is a characteristic feature of the works of the company, and there are in all about thirty similar rams in different places, most of which are operated by hydraulic pressure, at a pressure of 1000 pounds per square inch, piped from the state power house on the canal. Snow and ice are practically unknown at Folsom, and on this account it is possible to use hydraulic apparatus that would prove impracticable in a severe climate. The appliances for operating the head gates on the east side canal, and which are illustrated in Figure 6, are perhaps the most noteworthy of all. The gateways they operate are sixteen feet by fourteen feet in the clear, and are provided with gates opening to a height of twelve feet six inches above the sill, and made of three by twelve inch timbers, secured together by six bolts fastened through them. Each gate is attached by link and pin to the lower end of a piston six inches in diameter, made of wrought iron

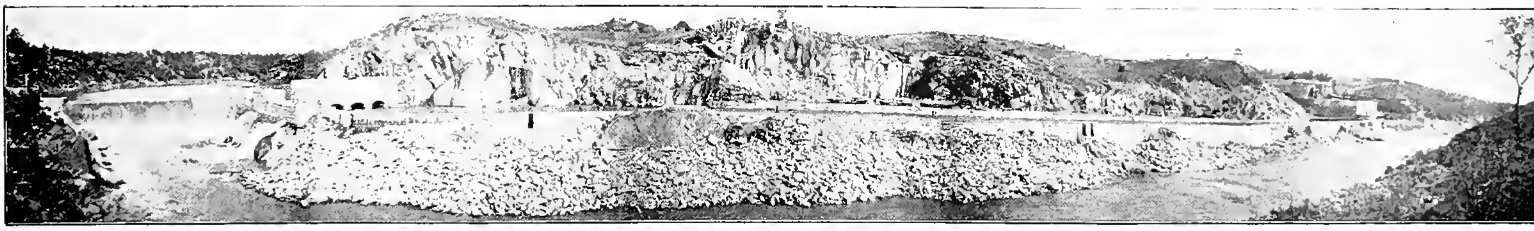


FIGURE 3.—SECTION 1 OF THE EAST CANAL OF THE FOLSOM WATER POWER COMPANY, SHOWING THE STATE POWER HOUSE IN THE DISTANCE.

and sheathed with brass. The brass piston, which is packed with cut leather, moves in a brass-lined cast iron cylinder of twelve-inch bore and thirteen-foot stroke, closed at each end with a stuffing box and gland to receive hemp packing. The pistons are operated by water under the pressure stated, which is delivered to the cylinders through a half-inch pipe. To provide against any movement of the gates by leakage of water in the cylinders, suitable checking gears are placed, there being two such gears to each gate, and these gears are keyed to a three and one-half inch shaft passing through the bracket by which the cylinder is mounted on the bulkhead. A wire rope runs from the top of the gate to each of the wheels, and a spiral spring is riveted at one end to a projecting casting on the gear, and is fastened at the other to a boss on the cylinder bracket.

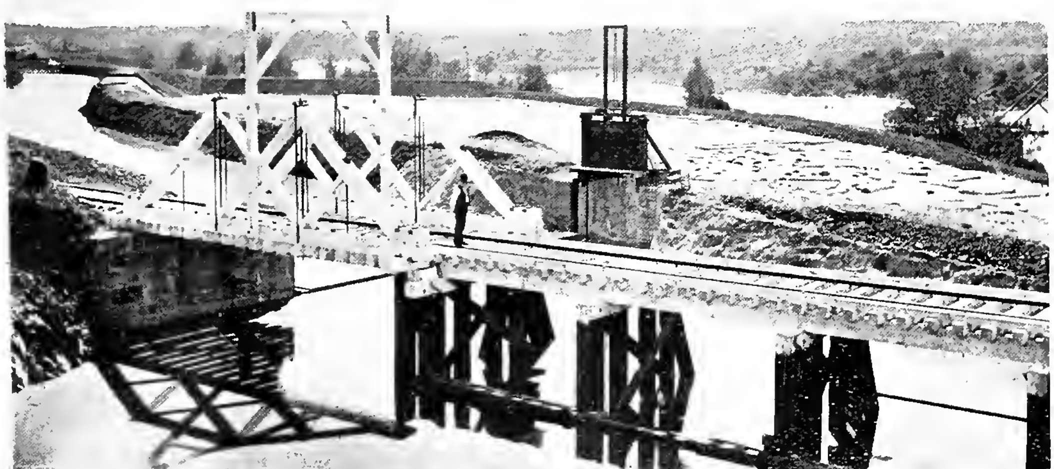


FIGURE 4.—ROBBERS' RAVINE, MARKING THE DIVISION BETWEEN SECTIONS 2 AND 3 OF THE FOLSOM WATER POWER COMPANY'S CANAL, SHOWING A LOG DAM OF THE AMERICAN LAND AND LUMBER COMPANY AND THE AMERICAN RIVER IN THE BACK GROUND.

THE EAST SIDE CANAL.

Two canals, known as the West Side and East Side Canals, are projected to continue on down the river from the dam. As yet the West Side Canal has not been constructed, but the East Side Canal is entirely finished. It is divided into three sections, the first of which extends from the dam to a point just below the first or State fall, where a drop of 7.33 feet in level occurs, at which is located the State power-house. At present the State is using about 800 horse-power of the power available from this drop. Section 1 is cut much of the way into solid granite cliffs, and the rock taken therefrom was almost entirely used in the construction of the dam and headworks on the east side and in the building of the heavy masonry wall, eight feet wide on the top, from fifteen to thirty feet wide at the base, and in some places as high as thirty feet. This wall, which is built on the bed rock, forms the outer bank of the canal. The section is provided with four sand gates, and is about 2000 feet in length.

Section 2 is constructed with an outside bank of earth and rock filling, on which is laid a broad-gauge railroad track, and at the lower end of the section are located four deep outlet gates, raised and lowered by hydraulic rams. Section 2 is 4000 feet long, and its inner side is faced by a heavy masonry wall, and the outer side is protected against the river by heavy riprapping.

The third section was built by the Folsom Water Power Company. It is made by earth and rock excavations and an earth rock fill, which forms the outer bank of the canal and which, as in Section 2, carries the railroad track. The outer bank is protected by rip-rap, and some portions of the inside are faced with dry rubble

wall. Section 3 is 3500 feet long, which makes the total length of the canal to be 9,500 feet.

The East Side Canal has a width of sixty-six feet above the headgates. From the headgates to the State fall, Section 1 has a width of fifty-three feet on top and forty-five feet on the bottom. Sections 2 and 3 are each fifty feet wide on the top and forty feet wide on the bottom. They carry water eight feet deep, and with such a grade that the water in the canal has an estimated flow of 104,000 cubic feet per minute.

Four sluice or sand gates, each covering an opening five by six feet through the wing dam, are located at the end of the dam to prevent sand or gravel from passing into the canal and causing injury to the wheels. The bottom of these gates is eight feet below the level of the bottom of the canal, and a short distance further down the stream an eight-foot wall is built directly across the canal. Inasmuch as ordinary gates placed in the side of the canal would only remove the gravel within a few feet of their entrance, three of the gates have a tunnel-like arrangement built through the outer bank, the mouths of these tunnels covering the entire width of the canal. As the entrances to these tunnels are eight feet below the bottom level of the canal, the water is not impeded in its flow thereby, and any heavy substance will be drawn into one or the other of the tunnel-mouths and be discharged through the sluices into the river below.

Between Sections 1 and 2, and immediately over the canal, the State of California has erected the State power-house previously referred to. This is adjoining the yard of the State Prison and is built of heavy granite masonry. It has a floor area of 166 by sixty feet, is sixty feet high, and within it are installed six special eighty-seven-inch Leffel turbine water wheels with vertical shafts, geared through beveled pinions to a horizontal shaft overhead. From this shaft power is delivered by cables and belting to a heavy set of pumps, to a large air compresser, to ice machines and to electric lighting generators. The arrangement at the State fall is such that the flow of water may be directed either to the wheels or turned into Section 2 of the canal through side gates operated by hydraulic rams, and in addition, a log chute or by-pass is provided to facilitate the passing of logs down the canal to the saw mill which it is proposed will be erected at Folsom. No water is wasted at the State fall, but the entire flow continues passing on down the canal.

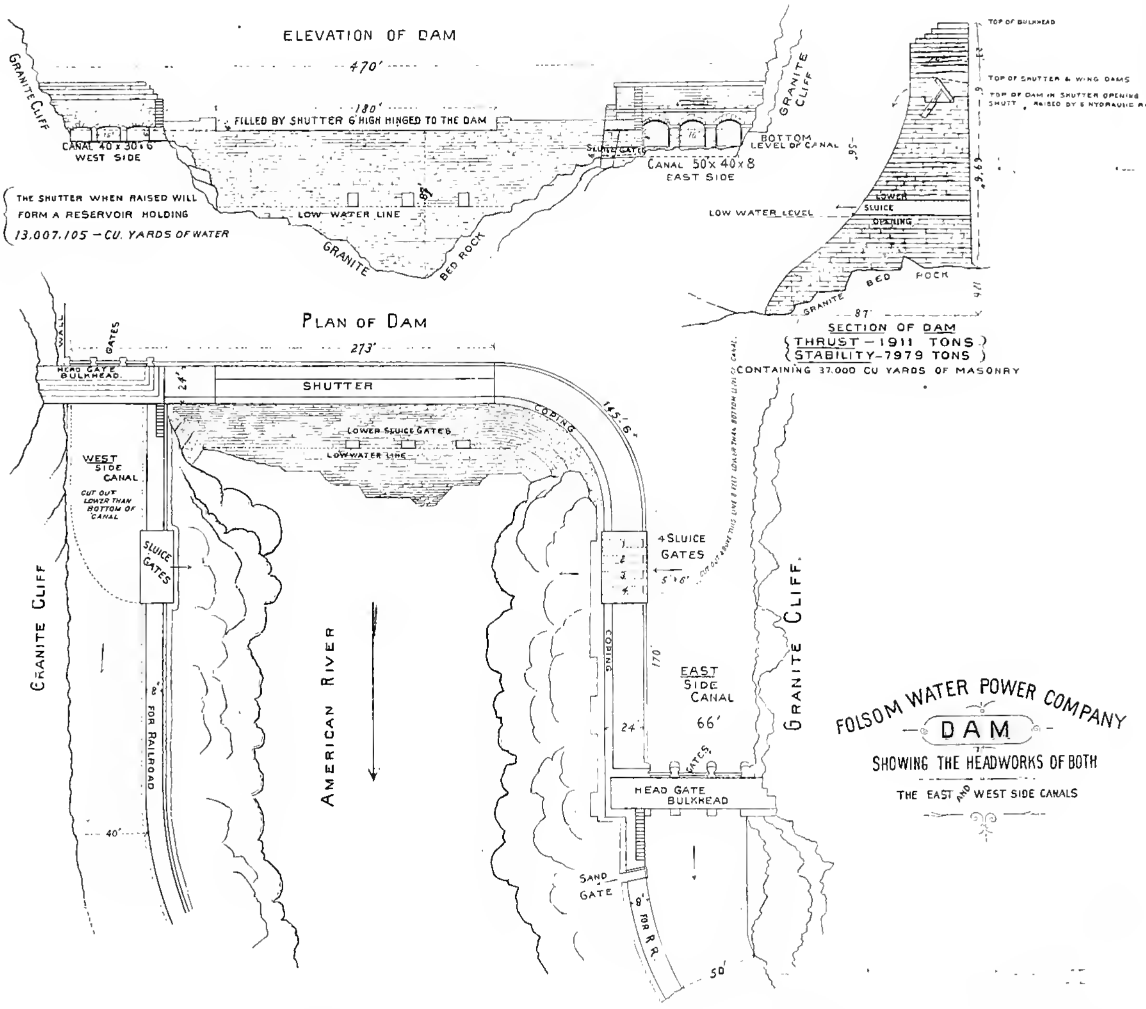


FIGURE 5.—AN OUTLINE PLAN OF THE DAM AND HEAD WORKS OF THE FOLSOM WATER POWER COMPANY.

At the lower end of Section 2 four other sand gates have been placed, but they are more for the purpose of

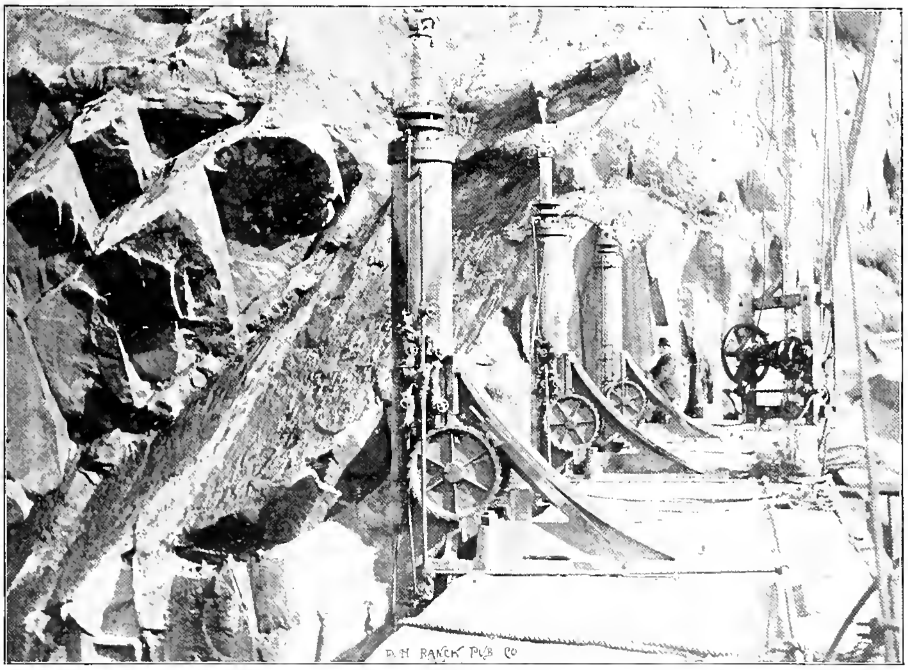


FIGURE 6.—HYDRAULIC RAMS OPERATING HEAD GATES OF THE FOLSOM WATER POWER COMPANY.

relieving the canal during storms than for clearing it of sand deposits. They are not, therefore, fitted with tunnels across the canal. The company's railroad crosses from the outer to the inner bank of the canal on a substantial truss bridge, supported by heavy masonry buttresses at the upper end of Section 3. Just below this bridge a timber boom is extended across the canal to deflect the logs into a large log basin covering several acres.

THE HYDRAULIC PLANT.

The dam and canal is the property of the Folsom Water Power Company, but the plant about to be described is the property of the Sacramento Electric Power and Light Company, which has acquired all the power rights for the water from the Folsom Water Power Company. At the terminal of the canal a forebay, 150 feet long, 100 feet wide and twelve feet deep has been constructed in a northwesterly direction at right angles to the canal. It is divided lengthwise by a continuous stone wall, reaching above the top of the water and extending from the canal to the power-house, so as to make virtually two forebays. Each of these is again divided longitudinally by planking which does not reach to the surface of the water, and gates are placed at each end of each forebay.

This construction was carried out because at certain seasons of the year much silt is held in suspension in the water of the American River, owing to the hydraulic mining constantly going on in its upper branches. The velocity of flow in the river and canal is sufficient to carry this silt along, and unless it were interrupted it would cause considerable trouble in the turbines. Advantage has therefore been taken of the fact that when a channel is widened out so as to cause slack water silt will be deposited, hence wide forebays were constructed. It will now be clear that in order to clean out the silt it will only be necessary to check the flow in one of the divisions of the forebay by closing the wheel gates and opening the waste gates, thus allowing a small flow to take place in the forebay, dropping out all silt with it. Then the water is again let in, and the wheels may be started and the other part of the forebay may be cleaned out.

But one forebay was completed up to the time of the Electric Carnival, hence the plant was operating to only half its capacity, but by October 1st the remaining forebay will be entirely finished, when the entire plant will be practically completed. The hydraulic part of the equipment was furnished by the S. Morgan-Smith Iron Works, of York, Pa., under contract with the Pelton Water Wheel Company, of San Francisco, and consists of four pairs of 30-inch McCormick turbines, having a capacity of 1260 horse-power each, and two of which, together with an exciter turbine, are illustrated in Figure 7.

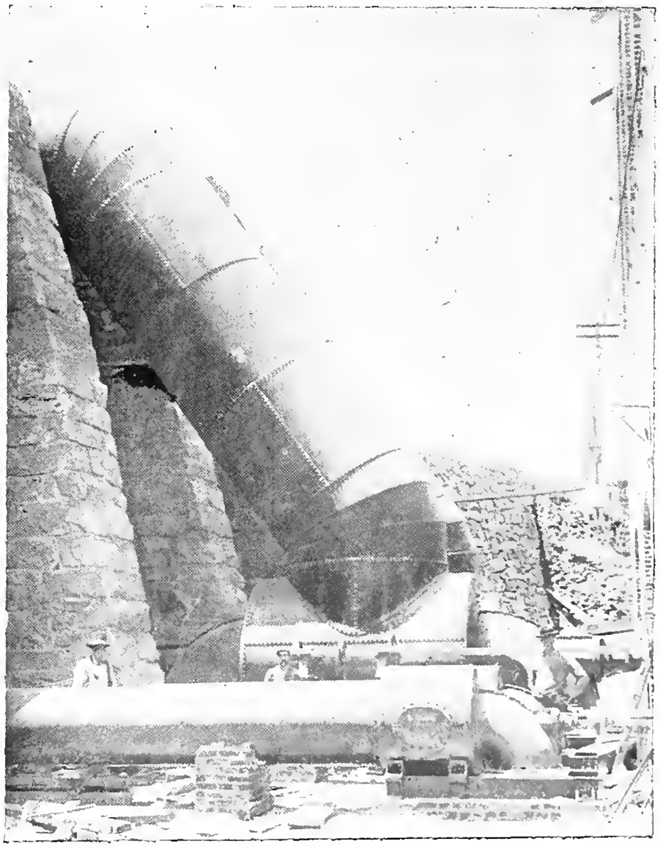


FIGURE 7.—PENSTOCKS AND TURBINES FOR TWO UNITS IN THE POWER HOUSE OF THE SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY.

The wheels run under a head of fifty-five feet at 300 revolutions per minute, and are directly connected to the armature shafts of the generators by insulated couplings. The inlet pipes are eight feet in diameter, and made of five-eighths-inch steel, with double draft tubes.

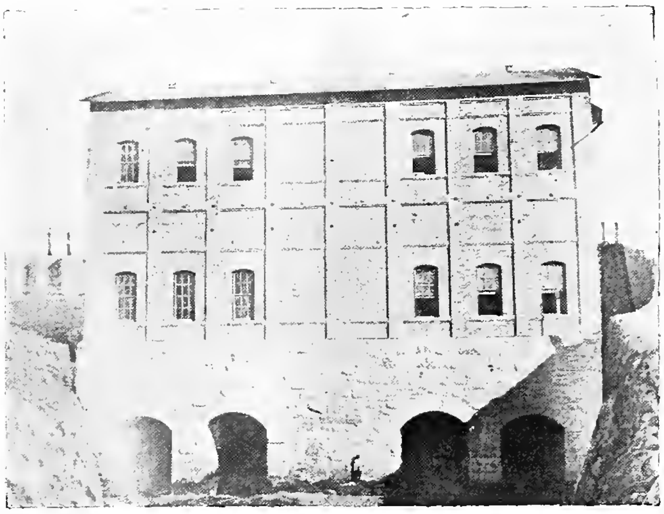


Figure 8.—The Power House of the Sacramento Electric Power and Light Company at Folsom.

Each pair of wheels is furnished with a steel flywheel ten feet in diameter, weighing 10,000 pounds, and which has a peripheral speed of 9425 feet per minute. To provide for the centrifugal strain that such a high velocity gives, heavy steel tires are shrunk on to the rims. The exciters are run by two special wheels of a size to give them the proper speed, which are also direct connected as in the case of the larger wheels. The governors are of the Feasch-Picard type, the same as are used on the Niagara wheels, and, being located in the generator room, are convenient for observation and control. Under the present temporary conditions it is necessary for an attendant to watch the tachometer and control the water manually.

The wheels are made of phosphor-bronze and the work throughout embraces the latest and most improved practice in hydraulics. The hydraulic equipment weighs upward of 400,000 pounds, and the plant, as a whole, is believed to be the most massive and powerful in the world, with the single exception of that at Niagara.

THE POWER HOUSE.

Coupled direct to each of these four turbines, as stated, through a 6 7-16 inch shaft fitted with insulating flanges, is a 750 kilowatt three-phase General Electric generator. At the time of the Electric Carnival only two of these generators, as shown in Fig. 10, were in operation, and these are without doubt the largest three-phase dynamos yet constructed. Their height is 8 feet 8½ inches, they cover a floor area of 11 feet by 8 feet 8 inches, and their weight is 57,877 pounds each. They are provided with twenty-four poles, and deliver a three phase current at a periodicity of sixty cycles per second and at a potential of 800 volts. The station is provided with two four-pole 500-volt exciters, having a capacity of 30 kilowatts each, and the entire four generators may be excited from either exciter.

From the generators the current is led through the simple switching-board, Fig. 10, to the bank of the step-up transformers placed in the transformer chamber on the upper floor of the building. These are of the large air-blast type manufactured by the General Electric Company, and each have a capacity of 265 kilowatts. Each generator feeds a group of three such transformers, making a total rated transformer capacity of 3180 kilowatts in the power house.

Only the dynamo potentials are handled at the station switchboard, which is, as stated, essentially a switching board. The two outside panels control the four generators, and as the board is provided with double sets of bus bars, the generators may be coupled to the circuits of the pole lines as desired. The center panel contains the synchronizing indicator lamps, the exciter instruments and the main line switches, while the generator panels, in addition to the switches, are provided with a voltmeter, current indicator, and the usual pressure regulator in each set. The switchboard is of Tennessee marble, and presents a very handsome appearance.

Both the primary and secondary coils of all step-up transformers are worked in parallel, taking current at 800 volts from the generators and delivering to the lines at a potential of 11,000 volts. Each generator is provided with a separate and distinct circuit from the power house to Sacramento, and they may be worked singly or in parallel, in the latter instance a synchronism being effected through the use of suitable indicators. As yet the transformers are run without the air blast, but as soon as the load increases sufficiently to cause material heating, both the power house at Folsom and the sub-station at Sacramento will be equipped with Sturtevant blowers, each operated by a 2-kilowatt inductor motor.

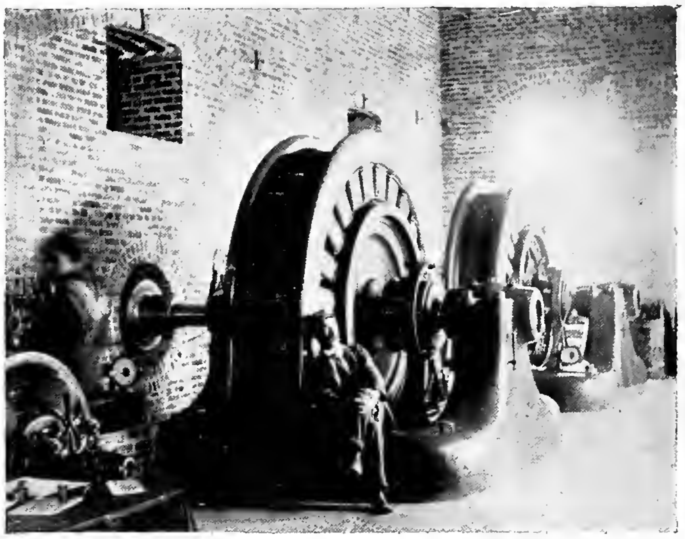


Figure 9.—Two of the Four 750-Kilowatt Three-Phase Generators in the Folsom Power House.

The power house, which is shown at Fig. 8. is divided into practically four parts. The photograph from which the accompanying illustration was made was taken before water was run into the tail-race, and at present the water comes up within a few inches of the arches. The tail-race forms the first section of the power house and the first story is divided into two portions, one for the turbines and the other for the electrical apparatus. The transformers occupy the upper story, forming the fourth portion of the station. The secondaries are led from the transformers to the pole lines out through twelve porcelain-lined holes in the end of the station, protected by a substantial hood.

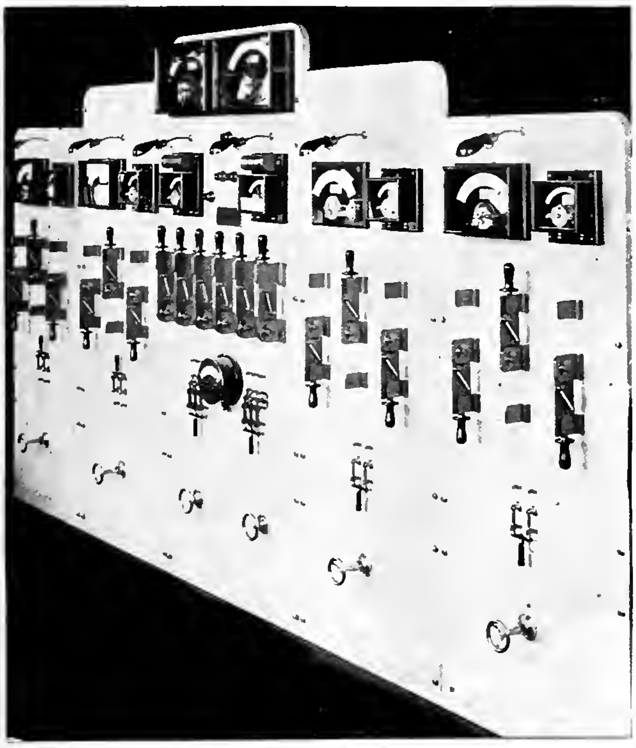


FIGURE 10.—GENERATOR SWITCHBOARD AT THE FOLSOM POWER HOUSE.

THE POLE LINE.

The pole line fittingly exhibits the care that has been exercised in the construction of the entire installation. It is a double line throughout, and following, as it does, along the sides of the country road and the Sacramento Valley railroad, it forms an avenue of poles 20.4 miles in length and of uniform construction. Forty-foot peeled Washington cedar poles of diameters averaging twelve inches at the top to sixteen inches at the butt, are used throughout the country division, but in the city sixty-foot poles have been placed at points of intersection with other pole lines. The transmission circuits proper, or those carried on the country pole lines, are supported on large special double-petticoat porcelain insulators that have been tested to withstand a potential of 25,000 volts A. C. The pole lines each support six No. 1 B. & S. bare copper wires, effecting transmission with an estimated line loss of ten per cent. Four such wires are carried by the upper cross arm and the two remaining wires by the remaining cross arms, as clearly shown in Figure 11. The illustration also shows that the poles are gained for two extra cross arms, with the intention of doubling the capacity when necessary. The cross arms, which are braced with angle irons, are seven feet in length, having a section of 4 x 4 inches, and the poles are set fifty to the mile, being placed six feet in the ground.

For many years the Sunset Telephone and Telegraph Company operated a long-distance telephone line between Sacramento and Folsom. It was of ordinary galvanized iron construction and grounded at each end, but as soon as the power transmission lines were put in operation the telephone circuit became useless from the induction. The new Capital Telephone and Telegraph Company, however, which has just been established in Sacramento, secured the privilege of placing a third cross arm on one of the pole lines a distance of thirty-six inches below the lowest power line. Number 14 bare copper wire is supported on porcelain knobs four feet apart, and the wires are transposed at every fifth pole. Columbia receivers and carbon transmitters are used, and the service is not only satisfactory between Sacramento and Folsom, but conversation may be carried on from Sacramento to Placerville, which is thirty-eight miles beyond Folsom, or a total distance of fifty miles.

The actual length of the power transmission circuits as measured by the pole line is as follows:

	Feet.
From the power house to the railroad depot at Folsom	1,056
From the Folsom depot to the limits of Sacramento	102,432
From the city limits to the sub-station	10,000
Total length of pole line	113,488

Or, practically, $21\frac{1}{2}$ miles.

FIGURE 11.—DOUBLE POLE LINE TRANSMISSION CIRCUITS OF THE SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY.

THE SUB-STATION.

The distributing station, as the step-down or substation of the Sacramento Electric Power and Light Company is called, is located on the northwest corner of Sixth and H streets, Sacramento, quite close

to the business portion of town. It is a substantial fire-proof structure, two stories in height, with an airy basement, and in addition to the general offices of the company, which, when completed, will occupy the front

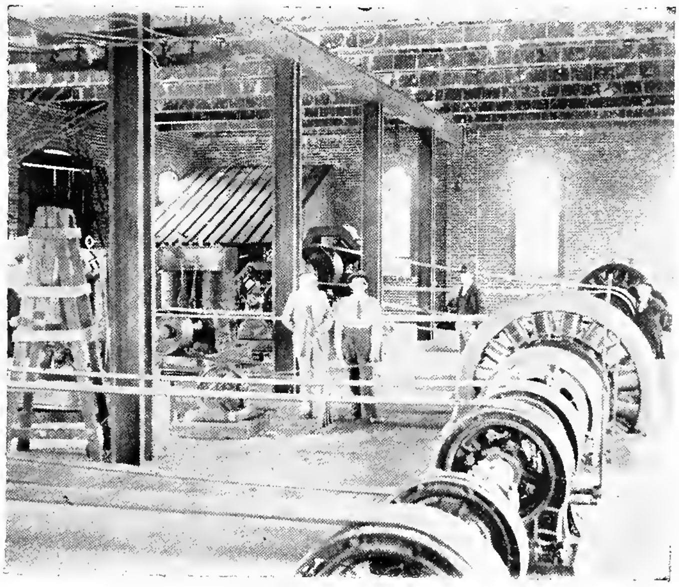


Figure 12.--The Motor-Generator Room in the Sub-station of the Sacramento Electric Power and Light Company at Sacramento.

corner portion, it contains the motor and generator room (Fig. 12) on the ground floor. This room has an area of 50 by 100 feet in the clear, and here are located the three 3-phase synchronous motors and the various electric railway generators, and arc lighting dynamos comprising the plant.

From the pole line the transmission circuits are led direct to the step-down transformer chamber in the sub-station. Only a temporary wooden apartment, which appears in the corner of the dynamo room (Fig. 12) is used at present, as the permanent chamber has not yet been completed. Here are located nine 125-kilowatt type "A B" or air blast transformers, taking energy at 10,000 volts, and transforming down to the various potentials required for the different forms of distribution.

The large 250-kilowatt synchronous motors are supplied with energy from six of the nine 125-kilowatt transformers, delivering current at 500 volts. The remaining transformers step down to 125 volts, the current being distributed over the city on a four-wire system consisting of three wires for the three-phase current, and of a fourth or neutral wire. The incandescent lighting service is rendered from extensions made between either of the three wires and the neutral, due care of course being maintained to keep the circuits balanced within reasonable limits, but the power service is rendered from the three-phase wiring without reference to the neutral in any way. Motors of large capacity will undoubtedly be operated from 500-volt three-phase wiring, while the 125 and 250-volt four-wire system will be used for incandescent lighting and small motor work.

The synchronous motors used are of the General Electric "A F" type, form A, and each have a capacity of 250 kilowatts. These motors are identical in all details. Each has sixteen poles, and develops 300 horsepower at a speed of 450 revolutions per minute. They are operated at an E. M. F. of 500 volts, the current alternating at a periodicity of 60 cycles. A peculiarity of the plant is the fact that the motors are connected directly in line with the main shafting through friction clutches, and all pulleys on the shafting are friction pulleys. The main shafting, including the motor shafts, is 91 feet 6 inches in length over all, and has a uniform diameter of seven inches. Its speed is, of course, identical with that of the motors, or 450 revolutions per minute, and from the shaft are belted direct: One General Electric, 4-pole, 200-kilowatt, 500-volt railway generator; two Edison bi-polar, 500-volt railway generators rated at 100 kilowatts each, and one Thomson-Houston M. P. 90,

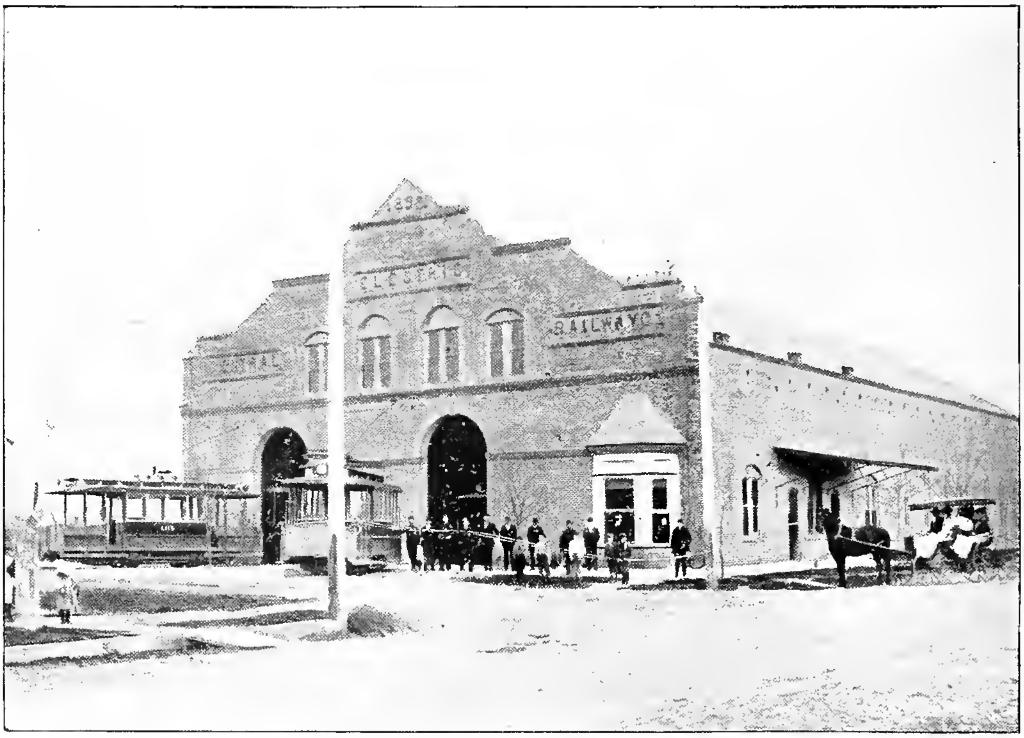


Figure 13.--The Car Barn of the Central Electric Railway Company, Sacramento.

500-volt generator; also three Brush arc lighting Class Y dynamos, each having a capacity of 100, 2000 candle-power arc lamps, and each of which, therefore, has a rated output of 9.6 amperes at 5000 volts. The approxi-

mate energy required to operate these dynamos at full load is 1000 horse-power.

No novel features are presented in the switchboards, which are of the usual fire-proof form. The sub-station will eventually contain four distinct boards, the first of which handles the incandescent lighting circuits of the city. From the second switchboard, which is fed with 3-phase current at a potential of 500 volts from the transformer room, the circuits run through the usual devices to the three 250-kilowatt motors described. The third switchboard will control the various railway generators and circuits, while the fourth switchboard is the standard form of arc lighting board designed and manufactured by the General Electric Company.

POWER CONSUMPTION.

An observation that should be emphasized in a description of the Sacramento Electric Power and Light Company's plant is the fact that a market for a considerable portion of its output is already contracted for. The transmission scheme itself is, therefore, a reality and not a venture, and of its consumers at the present time, the Central Electric Railway Company, comprising the entire street railway system of the city, is the largest patron. This road embraces 24.5 miles of a single track and 17 miles of double track, a standard gauge of 4 feet 8½ inches being used. The rails are of combination type, weighing from 35 pounds to 56 pounds per yard, according to whether they are used on the main thoroughfares or on branch lines. The cars are largely of the combination type, and the practice of equipping each car with a 15 horse-power single reduction motor has been adopted because Sacramento is an absolutely level city, and the simple single equipment has been found to be satisfactory in every way. Brill trucks are used exclusively, and in all the system comprises thirty-two motor cars and three trailers. The maximum power required to operate the system is 650 horse-power, but in laying out the station a surplus of 250 horse-power has been provided for extensions of the road, and the capacity available by the railway company from the transmission circuits, is, therefore, 900 horse-power.

The Company owns about three-quarters of the block bounded by Twenty-eighth, Twenty-ninth, N and M streets, upon the south-east corner of which is located the large brick car-barn illustrated in Fig. 14. This structure has a capacity of housing forty-eight cars, and in addition contains in the rear a well-fitted repair shop operated by electric power. Other buildings adjacent contain a blacksmith, carpenter and paint shop, while the offices of the general manager of the road occupy the front corner portion of the main building.

The system is well provided with features for attracting the patronage of the amusement-loving public. At East Park, on Thirty-first street, the company has erected the largest toboggan slide in the State, which is operated by a 10 horse-power electric motor run from the railroad circuit. Here a hotel has been erected, and the park itself is a very attractive recreation and picnic ground. Oak Park, which is owned by the company, is situated on the south-east corner of the city limits, and here are found lawns, gardens and other attractions, among which is an excellent dancing pavilion. The branch of the railroad reaching Oak Park also extends to the baseball ground, while on the M street line is located the well-known Sutter's Fort with its surrounding grounds, and which daily attracts hundreds of visitors.

New demands for power seem to be arising daily and negotiations are now in progress with the Southern Pacific Company for the placing of 900 horse power in motors in the railroad shops, which at present are operated by steam. These shops employ about 4000 men, and it is possible that the amount of power required for their operation may materially exceed the figure named.

Sacramento is located on a low, level country that is protected from inundations from the Sacramento river by means of levees built along its bank, as a result of which there is a considerable seepage of water beneath its soil, and at present this seepage is collected by means of percolation, and pumped back into the river, the power for running the pump being obtained from the city water-works. During the recent State Fair, however, the members of the City Board of Trustees were so impressed with the efficacy of operating centrifugal pumps from induction motors that they have now passed a resolution inviting proposals for the operating of the city pumping station by electricity, and as a result of which, it is believed that the Sacramento Electric Power and Light Company will receive the contract for delivering several hundred horse-power for the purposes named.

Referring to the question which has been raised from time to time as to the water-power available for use at Folsom, Mr. H. T. Knight, consulting hydraulic engineer for the Folsom Water Power Company and who has perhaps made more careful measurement of the water supply of the American River than any other person, reports that the available fall below the power-house from the tail race of the plant to the American River is twenty-six feet, while the head utilized by the present plant is 55 feet. This twenty-six-foot fall can be readily utilized, Mr. Knight states, by constructing about 100 feet of canal from the present tail race, fifty-five or sixty feet in length, to carry the water from the proposed supplementary power-house to the river. The present arrangements of the Sacramento Electric Power and Light Company contemplate the use of only about one-third of the capacity of the canal, and its remaining capacity may be made available for additional installations by a comparatively small outlay.

The electrical equipment of the system of the Sacramento Electric Power and Light Company was installed by the General Electric Company through its regular engineering corps, the work being placed under the general supervision of Mr. J. A. Lighthipe, Chief Engineer of the Pacific Coast office, who was assisted by Mr. A. C. Jewett, Superintendent of Construction at the power house, by Mr. B. O. Boswell, Superintendent of Pole Line Construction, and by Mr. C. O. Schaeffer, Superintendent of Construction at the sub-station.

The principal stockholders of the Sacramento Electric Power and Light Company, as well as of the Central Electric Railway Company, are Messrs. Albert Gallatin, Horatio C. Livermore, Charles E. Livermore and others. The officers of the first-named corporation are Albert Gallatin, President; Horatio P. Livermore, General Manager, and Joshua Barker, Secretary, and it is to the energy and enterprise of these gentlemen and Mr. Charles E. Livermore, that the installation of this remarkable power transmission is due.

THE CAPITAL GAS COMPANY.

Up to the present time the requirements of the Sacramentans for gas and electric light and for electric power have been catered to by the Capital Gas Company, a powerful concern that was organized by the consolidation of the Sacramento Gas Company and the Citizens' Gas, Light and Heat Company. The then new concern was incorporated, on January 4th, 1875, with a capital stock of $40,000, which was subsequently reduced to $10,000 while at present the amount is divided into 10,000 shares at $50 each, making a total issue of $500,000. Among the original incorporators of the Capital Gas Company, and all of whom are now holders of its stock to a great extent, are names that are known the country over. Leland Stanford, Mark Hopkins, Charles Crocker and C. P. Huntington all had considerable holdings, as did Wm. Alvord, now of the Bank of California, Oliver Eldridge, of the Pacific Telephone and Telegraph Company, and B. J Tallant, the banker. In addition to these, the Capital Gas Company now has coupled with it the names of B. U. Steinman, Mayor of Sacramento and who is President of the Company; C. H. Cummings, Secretary and Treasurer; Frank Miller, President of the Bank of D. O. Mills & Co.; Benj. Welsh; Oliver Eldridge, who is Vice-President; H. H. Taylor and H. C. Woods of San Francisco, and others — hence it will be seen that the commercial antagonist of the Sacramento Electric Power and Light Company is supported by men of the soundest financial standing.

The industry of electric lighting was not entered into by the Capital Gas Company until 1887, when the business, apparatus and good will of the Pacific Thomson-Houston Electric Company was purchased. The company was exploited by Mr. F. G. Waterhouse, and constituted the first effort of the parent Thomson-Houston company to introduce its electric lighting machinery on the Pacific Coast; its "apparatus" consisted of one 12-lamp 2000 candle power arc lighting dynamo and one 25-lamp dynamo, which were among the first brought to the Pacific Coast; hence it is clear that the subject of this sketch is at least entitled to mention in electrical history.

At the present the Capital Gas Company is operating practically all the electric lights, both arc and incandescent, burned in Sacramento; but the electric power consumed is, on the other hand, most generally furnished by the Sacramento Electric Power and Light Company. Incandescent service is furnished both by the flat rate and meter systems, the rate for the latter being 15 cents per kilowatt hour, with a sliding scale of discount according to the amount consumed. For arc lighting by 2000 candle power lamps the weekly rates vary as follows: Nine o'clock circuit, $2; ten o'clock circuit, $2.25; twelve o'clock circuit, $2.75, and all night circuit, $3.50. The gas rate for lighting and fuel purposes is $2.50 per thousand cubic feet.

Figures 1 and 2.—The Electric Power House and Gas Works of the Capital Gas Company, Sacramento.

The power house of the Capital Gas Company (Fig. 1) is a substantial brick building having inside dimensions of 124 feet by 104 feet. It is of thoroughly fireproof construction, and contains no wood work or timber whatever, except the door and window casings and the mats about the high potential dynamos. It is divided by a fire wall into two portions, known as the dynamo and boiler rooms, the former being 124 by 64 feet in area, and the latter 124 by 40 feet. The roof over each is of corrugated iron, supported by iron trusses, and beneath the dynamo room is a basement 12 feet high. The floor of the dynamo and engine room is supported by brick piers and steel **I** beams which carry brick arches

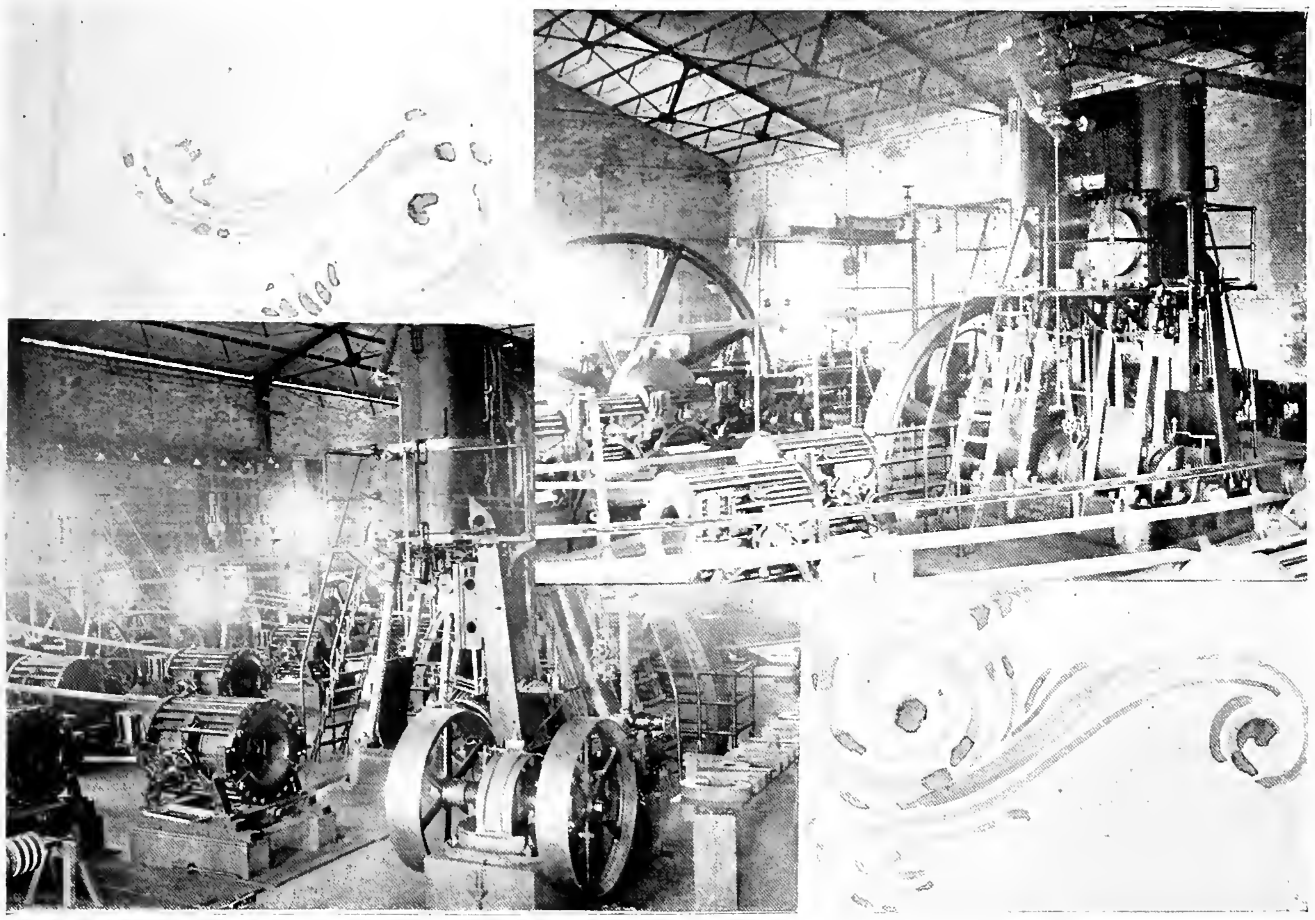
over which is placed the concrete floor. The entire consirnction is most substantial, and is designed with the idea of preventing a recurrence of the destructive fire which consumed the plant in April, 1894.

In the boiler room is a battery of six Babcock & Wilcox water tube boilers having a working capacity of 900 horse power, and which operate under pressure as high as 140 pounds to the square inch. The boiler feed pumps consist of one 6-inch Dow pump having a capacity in excess of the requirements of the boilers, together with an auxiliary of two 4-inch Buffalo duplex pumps. In addition, the boiler room contains a 5-inch Buffalo duplex pump, to be used for fire purposes. A large horizontal flue extends along the rear of the boilers for a distance of over 70 feet, ending in the chamber of the brick stack This stack, which is 140 feet high and circular in form, rests on a brick foundation that is 30 feet square, and its base, which is 18 feet square (outside measurement), contains the chamber, 13 feet square. At a height of 30 feet this chamber is brought to the cylindrical portion of the stack proper, and extends to the top with an internal diameter of 7 feet. Not only the stack but the entire station was laid out for an ultimate capacity of double the present size.

The condensing plant is located in the basement of the station, and consists of three Davidson condensers each having a capacity of 650 horse-power. The engines are connected to an exhaust header so arranged as to use one or more condensers at any time. Condensing water is taken from the Sacramento river, on the bank of which the station is located. From the hot well the water is passed through Baragwanath tubular heaters. The water is practically free from scale, as it never forms more than a mud scale 1-16 of an inch thick, which soon scales off.

As is well known, the item of fuel has always been of serious concern in California, and, as a result of careful experiment, the Capital Gas Company has now adopted and is using Ione coal, under a forced draught of ¾ inch pressure. This is a lignite coal mined not far from Sacramento, and which has a market value of $1.80 per ton. It is only recently that it has been found possible to use Ione coal to any advantage, otherwise its low price, as compared with the rates of $6 and $7 per ton for ordinary coal, would have brought it into extensive use. The boilers are also fitted for burning Welch anthracite coal should it be necessary for any reason to change from Ione coal. The plant has coal storage bins for about 4000 tons for the electric light plant and for about 7000 tons for the gas works. The Company imports all coal direct.

The motive power for the electric plant consists of three engines, each of which is belted direct to the countershafting, which is along the north wall of the building under the switchboard gallery. The first engine is a cross compound Corliss condensing engine, built by the Risdon Iron Works of San Francisco. It has a stroke of 48 inches, with cylinders 22 inches and 40 inches in diameter, respectively, and, running at 80 revolutions per minute with steam at 120 pounds, it develops 600 horse power. The next engine is a triple expansion marine type vertical, built by the San Francisco Tool Company, and which has a capacity of 400 horse power at 140 revolutions per minute. The stroke of the engine is 30 inches; the high-pressure cylinder has a diameter of 15 inches, the intermediate cylinder has a diameter of 24 inches, while two low pressure cylinders each having a diameter of 24 inches are used. In order to economize floor space, one of these low pressure cylinders is placed in tandem over the high pressure cylinder and the other



Figures 3 and 4.—Interior of the Electric Light Plant of the Capital Gas Company, Sacramento.

is in tandem over the intermediate cylinder. The third engine is a simple Reynolds Corliss, 20 by 48 inches, run condensing, and which delivers 250 horse power at 78 revolutions per minute.

These engines all belt together from their fly wheels to the line shafting, a double leather belt 30 inches in width being used on the Reynolds Corliss and rope transmission being used on the other two engines, the Risdon cross compound being equipped with ten 2-inch single manilla ropes and the vertical engine being equipped with the Link Belt Company's rope transmission, using $1\frac{1}{2}$-inch manilla ropes. The driven pulleys of the countershaft are equipped with Hill clutch couplings, except for the vertical engine, which is so arranged with flanges as to be detachable, in order that, if desired, it may be at rest while the shaft is in motion. The countershafting runs at 272 revolutions per minute, is equipped throughout with self-oiling bearings, is 100 feet long, and its diameter varies from $5\frac{1}{2}$ inches to $4\frac{7}{8}$ inches. The driving pulleys on the countershaft are, wherever necessary, equipped with Hill clutches.

The generating plant consists of eleven 50 lamp Thomson-Houston arc dynamos and two 35 lamp arc machines of the same make. Also one "D 62" 500 volt Thomson-Houston power generator for the distribution of both light and power on metallic service, together with one 60 kilowatt Thomson-Houston alternator and two 120 kilowatt General Electric alternators. All leads from dynamo to switchboard are carried in iron-armored conduits under the floors and up along a wall of the station to the switchboard gallery, which is constructed entirely of iron and marble, with the usual fittings common to the latest type of fire-proof switchboards as manufactured by the General Electric Company.

Overhead distribution is used exclusively, and the pole lines and circuits for the various services embrace all the principal streets, while the entire city is covered by the arc circuits for public lighting. The main pole line from the station to the business centers consists of sawed Santa Cruz redwood poles, 16 inches square at the butt and 10 inches square at the top. Eight-pin cross-

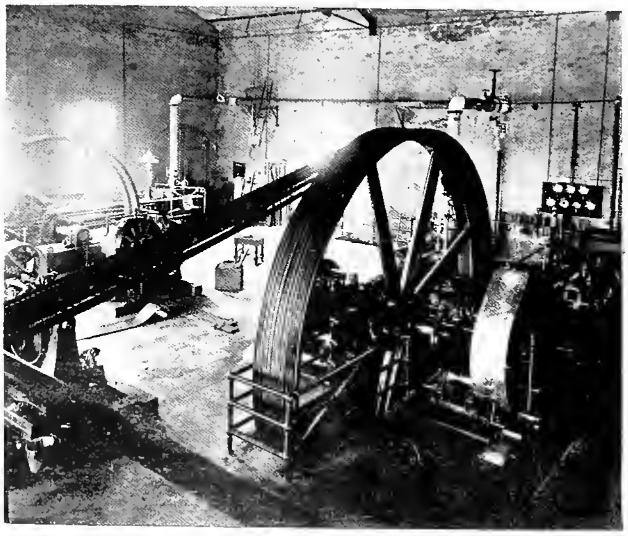


Figure 5.—Interior of the Electric Light Plant of the Capital Gas Company, Sacramento.

arms, 4 inches by 6 inches, are used, and the construction is very substantial.

The Directors of the Capital Gas Company have long since realized that it is the province of organizations of their class to furnish illumination in whatever form the public may demand, whether that be as gas or as electric light, hence in the prosecution of their lighting business they have given great attention to the development of their gas works. This is principally contained in an irregularly shaped building constituting the retort house, which has an area of 66 by 100 feet, and the purifying and lime house, having an area of 60 by 80

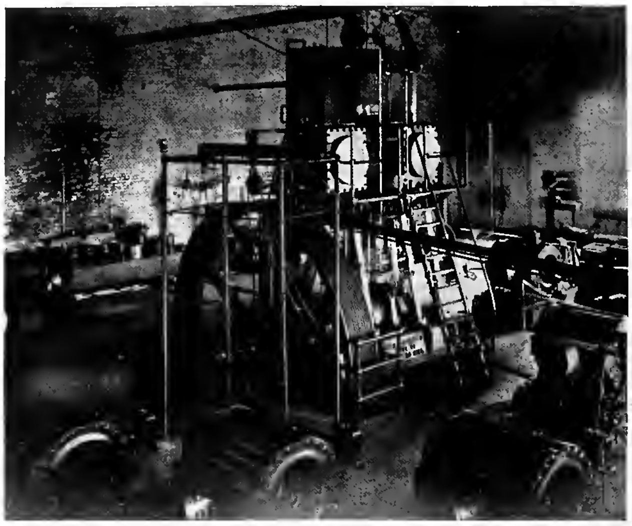


Figure 6.—Interior of the Electric Light Plant of the Capital Gas Company, Sacramento.

feet. In this combined building are contained the engine and pump rooms, the scrubber and purifying rooms and the lime storage. In the retort house are eight benches of six retorts each, each bench being heated with a half depth regenerative furnace. A six-foot setting of the Lowe double superheater, with all necessary pumps, injectors, elevating machinery, meters, steam and air plant used in the generation of water gas, are used. Two seven-foot MacDonald station meters, each having a capacity of 300,000 cubic feet per day, are here located, while on the grounds are three gas-holders, each having a capacity of 70,000 cubic feet. The gas produced is of 20 candle power absolute.

PERSONAL.

Mr. G. Gustavson has been appointed General Manager of the Oakland, San Leandro and Haywards Electric Road, vice F. M. Leland, resigned.

Mr. V. J. Mayo, has resigned the Superintendency of the Capital Telephone and Telegraph Company, and is at present in San Francisco.

Mr. T. P. Hornsby, representing the National School of Electricity, is organizing classes for the schools in San Francisco.

Mr. Michael T. O'Day, M. S. E. E., Professor of Applied Electricity, University of Notre Dame, Indiana, is visiting San Francisco and other California cities for rest and recreation.

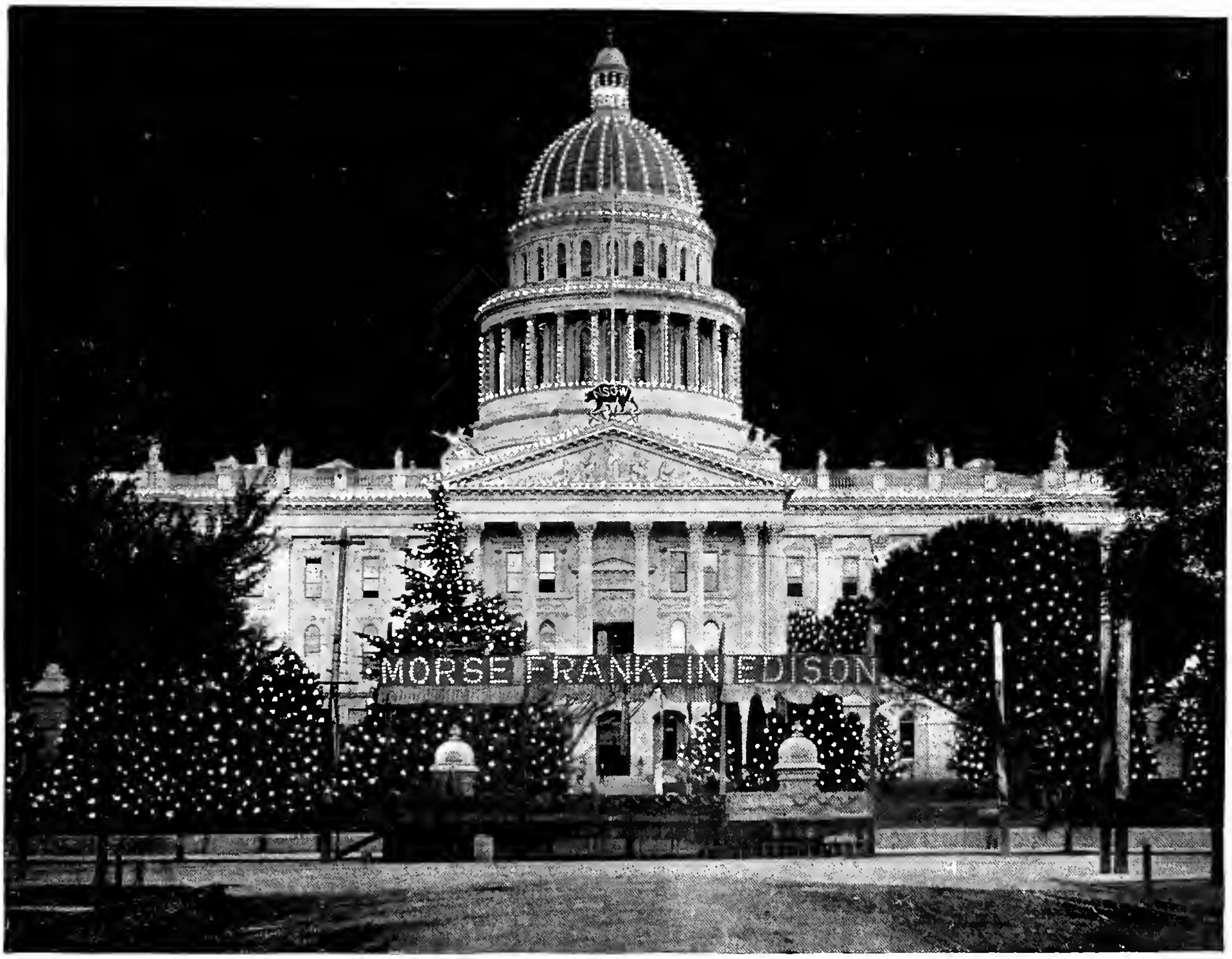
Mr. Francis O. Blackwell, Chief Engineer of the power and mining department of the General Electric Company, and who has been spending several weeks of his vacation on the Pacific Coast, has returned to the East.

Mr. W. S. Heger, universally known as a pioneer in the electric lighting business, has assumed the managership of the Pacific Coast office of the Westinghouse Electric and Manufacturing Company, with headquarters in the Mills Building San Francisco. His many friends on the Pacific Coast are pleased to know of his return and wish him unlimited success.

THE ELECTRIC CARNIVAL.

Resplendent indeed was the scene, when, on the perfect evening of September 9th the joy felt by the people of the city of Sacramento over the completion of an enterprise that assured a cheap power to its languishing industries, gave outbursts of approval in the decorations of gaudy carnival array, in brilliant illuminations, in electric pageants, and in the hospitality that has become proverbial to California and Californians. The occasion was one of triple jubilee; the State Fair, that has yearly drawn thousands to the Capital City, was in progress. Then it was "Admission Day"—the forty-fifth anniversary of the entry of California into the sisterhood of States—and thousands upon thousands of members of the Native Sons of the Golden West, which is the mightiest social organization in California, were gathered to honor the natal day of their beloved State. The success at the Fair had been unprecedented, and never before had the attendance to the celebration of the Native Sons and Daughters been so large, or had the "Parlors," as the lodges are termed, gathered in such good cheer and merriment. It was a gala day indeed, with its magnificent parades and sumptuous receptions, but its crowning feature was the "Grand Electric Carnival," to the success of which loyal Sacramentans had devoted weeks of time, and spent thousands of dollars. Nor were their exertions in vain, for never before has the world witnessed such a sight, nor never again can a community experience the novelty and enthusiasm of those who are proud in the knowledge that they have accomplished an undertaking never before attained.

Picture, if you will, broad thoroughfares forming the principal streets of a community whose long lines of low, two-story buildings, and with here and there modern office buildings and mercantile houses cropping far above their lowly neighbors, betoken a recent development into cityhood. Its smooth, paved streets and broad, well-kept sidewalks indicate a spirit of enterprise, and when, on looking further one finds some of the largest and finest retail stores in the West, he feels anew that Sacramento is fast becoming metropolitan in its way. But on this night its streets are densely thronged with people whose radiant, expectant faces speak of some approaching event, even were not these streets arched and bedecked in the most brilliant raiment of carnival colors, or were not the buildings, as far as eye could reach, simply ablaze with thousands of decorative lights. Everywhere, from the miles upon miles of bunting upon the streets to the paper boutonniers upon the lapels of many coats, were present the carnival colors of green and yellow and red to offend the æsthetic taste, yet withal to lend allurement and enchantment to the scene. Everywhere, from the top of the Maypole, nearly two hundred feet above the ground, to the harness on the horse of a peddler of chewing gum, were incandescent electric lamps seemingly without number, increasing by many fold the brilliance of the colors. Arches of light and arches of triumphal character spanned the streets. Yet others flashed out a cheering welcome, or told of the



Electric Illumination of the State Capitol on the Evening of September 9, 1895.

dawn of the day of progress or of a new era—"The New Sacramento."

Picture again, then, scenes with augmented crowds, which, though filled with merry-making and perchance revelry, are silent at the first strain of music, and with much tip-toeing and craning of necks, look eagerly down the level distance for the coming of the now-delayed procession. At last, in lurid outlines, the royal pageant approaches, slowly and majestically, until now before us is "Old Glory" outlined in colors of fire. With one accord the voices of the people are raised in loyal cheer, for in all the splendor of carnival attire, in all the expectancy of wonders electrically wrought, that grand old flag appearing in the National float, appropriately leading the procession, awakened a patriotic sentiment in every heart.

As to the pageant itself, any one who is familiar not only with the effects which may be obtained through the artistic arrangement in decoration of allegorical floats, but also with the extreme brilliancy of electric cars elaborately illumined for trolley parties, will experience no difficulty in conceiving an idea of the scene. In the National float the flag was 7½ by 12 feet in size, and the stars and stripes were excellently portrayed by red, white and blue incandescent lamps. The body of the float represented a camp scene covered with natural grass and flowers all illuminated by the subdued light from incandescent lamps artfully concealed. At the front of the float was the National shield in red and white lights, with silver stars surmounted by an eagle, while stacks of muskets and a cannon, on either side of which were cannon balls, were placed upon the grass. In the rear was a grizzly bear in the attitude of an intruder in the camp. The float, which was the conception of Director-General J. O. Coleman, was very tastefully draped in flags and bunting, and was illuminated by 525 16-candle power lamps. The float was mounted on a flat car, which was pushed by an illuminated trolley car containing a number of Federal officers and officials of the Sacramento Electric Power and Light Company.

The State float followed this, in the center of which was a golden throne on which sat "California," and seated at her feet was "Sacramento." Aside from the festoons of light interwoven amidst draperies of plush and satin in blue and gold, the magnificent bouquets of cut flowers, illuminated with miniature lamps, constituted the chief features of interest. As with the National float, the car bearing the State float was pushed by an illuminated trolley car containing officers of the State of California.

The Fruit and Flowers' float bore the carnival colors of cherry-red, apple-green and poppy-yellow. It was profusely garlanded and bedded with the choicest of fruits, flowers, evergreens, palms and ferns. Queen Flora's throne was supported on either side by illuminated wreaths mounted on silvered lattice work, in front of which was a vase holding ten large California poppies wrought in electric lights. On each corner was a brass post four feet high, surmounted by colored lights, and on the center of either side was an illuminated shield, which, together with other decorations, consumed the 300 lights that were used on the float. The trolley car pushing the Floral float contained the grand officers of the Native Sons and Native Daughters of the Golden West. Then came two illuminated trolley cars, lavishly decorated with bunting and colored lights, carrying members of the Sacramento County Pioneer Association.

These constituted the floats constructed by the Carnival committee, and which were the most artistic. The employes of the railroad shops of the Southern Pacific followed with twelve floats of their own design and construction, that represented the various trades employed in the great shops of the Company. Among the designs submitted, worthy of special mention, were the Electric Locomotive, built by the Machine Shop; the Beehive, by Car Shop No. 5; the Flaming Cupola, built by the Foundry and Pattern Shop; the Electric Star, built by the Car Machine Shop; the Electric Furnace, built by the Rolling Mills; Franklin's Kite, by the Boiler Shop; Electric Hammer, by the Blacksmith Shop; Ornamental Designs, by the Paint Shop; Mechanical Designs, by the Car Shop, and an Electric Fountain, by the Copper and Pipe Shops.

The route of the procession followed through three miles of streets, over which were various electric arches and signs, among which were the following:

The Horse-shoe, containing 225 white 16-candle power incandescents;

The Maypole, containing 510 red, yellow and green lamps;

The "New Sacramento," 500 red lamps;

Progress, 300 yellow lamps;

Welcome, 400 white lamps.

Perhaps the most striking of these was the Maypole. From the summit of the liberty-pole, 185 feet high, were arranged six strings of 16 candle power lamps in multiple, each string containing 85 lamps, in carnival colors, which was so arranged as to give the effect of spirals of different colors encircling the May Pole. The colors started with a red appearing first on one string, following as second on the next and third on the third, and so on, thus forming the spiral effect. The lamps were operated at a potential of 115 volts, and were supplied from the three-phase incandescent circuit of the Sacramento Electric Power and Light Company.

Without doubt, the illumination of the State Capitol building presented the most brilliant appearance, and, together with the illumination of the grounds, afforded a scene surpassing in effect that of any single similar effort heretofore attempted. The roof and dome of the Capitol building were outlined with 2000 16 candle power incandescent lamps, and, as the bear of the Native Sons of the Golden West which surmounted the roof contained 600 lamps, and the interior of the building was illuminated with 600 lamps, there were 3200 lamps used in and on the building. Surmounting all were 12, 2000 candle-power arc lamps placed on the apex of the dome. In addition, the twenty-four trees facing Tenth street, and forming the foreground of the Capitol, were brilliantly lighted with 2000 yellow, green, red and white incandescent lamps.

The methods of wiring utilized in effecting the illumination of the Capitol and grounds are interesting, as it can be readily understood that the installation of such a large number of lamps on an ordinary system would be impracticable because of the fact that no station carries so large a reserve capacity as would be necessary to meet such unusual demands. The Capitol itself, therefore, was lighted from the regular 1080 volt incandescent alternating system of the Capital Gas Company, each circuit consisted of 100 volt multiples of 16 candle power lamps in series direct across the primaries. These multiples were of varying numbers of lamps. On the rows forming the eaves of the roof, for instance, 27 lamps were placed in each multiple, while 10 lamps constituted a multiple on the vertical columns, and on the dome from 20 to 30 lamps were placed in parallel. Great care was necessary in effecting the installation to prevent the occurrence of grounds, as the roof of the building is entirely of metal, hence sockets were placed on wood strips which were laid upon all flat surfaces or temporarily secured to the curves. The illumination of the trees was effected from the railway circuits of the

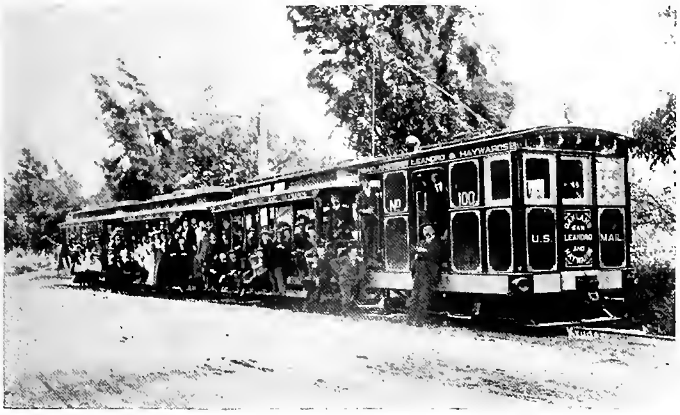
Central Electric Railway Company, which is, as stated, operated by power from the American river, at Folsom. Series multiple wiring was used throughout, the circuits being made up of five multiples of lamps in series, each multiple carrying from nine to 11 lamps. There were generally ten such series multiples to each tree. The lamps tinted with carnival colors, together with many white lamps. were used, the only deviation from the usual color arrangement being that twice as many green lamps as any other color were used.

The bear appearing on the roof the Capitol was illuminated by current taken from the Folsom power. It was about fifteen feet long by eight feet high, and contained 600 16 candle power lamps wired in simple series and operated from the trolley circuit.

THE HAYWARDS ELECTRIC LOCOMOTIVE.

The Oakland, San Leandro & Haywards Electric Railway Company is one that has always been prominently before the public and the electrical interests, because of its enterprise and the many features of superiority the system possesses. Embracing in all twenty miles of track, the system begins at the foot of Washington street in Oakland and extends thence through the business portion of the city to East Oakland and on through the towns of Fruitvale, Melrose, Fitchburg, Elmhurst, San Leandro and Haywards, terminating in a pleasant canyon at the eastern limits of the last-named town. A branch line, a mile in length, runs from the main road to San Leandro, and throughout practically the entire line the road parallels the Southern Pacific system, which before the advent of the Haywards line had a monopoly of the traffic. From the outset the competition between the steam and electric lines has been very keen, and it now appears to have reached its zenith, as the Southern Pacific Company has put on extra local trains with superior service and is running at very close intervals with materially reduced fares.

It is with the intention of meeting this competition all along the line that the electric road has placed an express service in operation, and will at the earliest opportunity effect connections by which passengers can be landed through from any point to San Francisco. At



THE HAYWARDS ELECTRIC LOCOMOTIVE.

present the Southern Pacific Company controls the through commutation business between Haywards, San Leandro and San Francisco, but the bulk of local traffic is by the electric line, and in addition, a new and profitable industry has been developed by the carrying of farm products to Oakland and the metropolis. The very productive region in and about Haywards has never contributed materially to the income of the Southern Pacific Company because the freight rates that have prevailed have been so high that it has been cheaper to carry the garden truck in by team than by rail. In order to secure this trade the Haywards line accepted the recommendation of Mr. F. M. Leland, then General Manager of the road, and built the electric locomotive known as "No. 100" and shown in the accompanying illustrations. This is equipped with two 50 horse-power motors and a series

THE HAYWARDS ELECTRIC LOCOMOTIVE.

parallel controller, and the unusual weight of the locomotive—21,400 pounds—is due to the fact that under its floor is placed a layer of railroad iron. Steam locomotive practices are followed out to a large extent as, for instance, locomotive driving box brasses are used and the locomotive is equipped with air brakes.

The air compressor forms a feature of interest. It is operated by an independent electric motor manufactured by the Electrical Engineering Company of San Francisco and having a capacity of three horse-power. The motor is mounted on a single base with a duplex air pump which the former drives through a single reduction gearing. Through an ingenious arrangement of the Electrical Engineering Company's starting rheostat and a pressure valve of ordinary type, the entire mechanism is automatic in action and requires practically no attention. This compressor is due to Mr. G. Gustavson, Master Mechanic and Superintendent of the road, and is used with the greatest success. In addition to the locomotive, the freight or passenger trailers hauled by the electric locomotives are equipped with air brakes, as are also the 32-foot combination cars operated on the main line. The whistles are also operated from the same source.

The distinctive feature of the express service of the Haywards Electric Road rests in the plan adopted of running the loaded wagons on the cars and carrying them to destination, which can be accomplished quicker and more cheaply in this way than in any other manner. The locomotive is in hard service regularly on week days and performs even harder work on Sundays in hauling picnic trains.

AS OTHERS SEE US.

The ELECTRICAL JOURNAL, published at San Francisco by Geo. P. Low, is the latest electrical exchange to hand. It is designed to represent the electrical interests of the Pacific Coast and has a large amount of local information. —[Canadian Engineer, Toronto, Ont.

......As our Golden Gate contemporary [THE ELECTRICAL JOURNAL, San Francisco] is a handsome paper, well edited, and something after our own style, we predict and hope for it a large measure of success.—[The Electrical Journal, Chicago.

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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EDITORIAL.

AN OPPORTUNITY LOST.

Without doubt the thousands of spectators who found much to admire in the most elaborate display of lighting effects witnessed during the recent Electric Carnival pageant at Sacramento, will share the pangs of regret experienced by the publisher who would record such scenes in words of description and in artistic illustration, on learning that despite the efforts of several local photographers there is not to be obtained a single illustration of even a single float that would make a creditable appearance or that is worthy of reproduction. That such a situation can exist in an enlightened American city which aspires to National prominence is not only a matter to be deplored, but tends to lead to the conclusion that Sacramento affords a promising field for an enterprising photographer.

"WHAT'S IN A NAME."

The last issue announced a change in the name of this publication from that of "The Electrical Journal" to "The Journal of Electricity." This early change has been occasioned by the almost simultaneous publication of two periodicals with the same title. Whatever may be the facts as regards the rightful ownership of the name in question—"The Electrical Journal"—we deem it advisable, in the interests of our readers and of harmony, to take this step to prevent all further confusion which might occur on account of the title.

The original idea of publication and the adoption of the name were very much earlier than the actual date of the printing and copyright, and we believe that our plans were sufficiently well known to the electrical fraternity throughout the country to have avoided this coincidence. From the information we have been able to gather we firmly believe that we were the first to adopt the title which we now relinquish. We were not the prior in the field; and since the two journals have been published we believe that our methods and matter will not gain by being confounded with those of our contemporary.

We desire no newspaper controversy in regard to the question of the title. This paper will continue to stand upon its own grounds, and the success it has already attained will not be forgotten because of this change. Nor are our plans altered in any respect by the announcement that it is now to be called "The Journal of Electricity, an Illustrated Review of the Industrial Applications of Electricity, Gas and Power."

THE NEWER SACRAMENTO.

The columns upon columns of complimentary matter that have appeared in the lay press eulogizing the enterprise of the men who have made Sacramento famous as being the first American city to demonstrate the practicability of long distance transmission of power at high voltage, have told most exhaustively of the success achieved, but what has been said in engineering papers concerning the electrical distribution of power in manufacturing centers, and which is now about to be put into practice in that city, has received little, if any, attention on the part of the public. From Folsom there has been delivered, and is today in use in Sacramento, a very considerable amount of power, and it is understood that during the coming winter an equal or greater amount of electrical energy will be delivered over the transmission lines of a new company. In addition, it is understood that the plant of the present gas and electric company is to be brought to the highest degree of efficiency attainable, whether that be in the use of steam or gas engine equipments, in order that it may carry out its plan of competition to the fullest extent, and while no doubt the residents and users of power will be greatly benefited by the availability of power which may be furnished in either large or small amounts, and always at the lowest possible cost, electrical engineers will be especially interested in the result of the competition between electrical power derived from waterfalls situated at a considerable distance, and the generation and transmission of power from coal over the lines of the local company.

It seems that the public is at last about to realize that the blight of high-priced fuel has brought, or may be made to bring, the blessing of cheaper electric power, and while, of late years, electrical engineers have not doubted the technical feasibility of transmitting power over great distances, a serious doubt does exist, not only with engineers, but with capitalists as to the commercial feasibility of many such projects. Bearing ever in mind the potent factor of local conditions, the cold, hard question that must receive equally impassionless consideration, is, Which has the greater earning capacity, the electrically transmitted power of a distant waterfall or the electric power from a central station? No one doubts that both of these systems are engineering successes. As the business of the two systems is to deliver electrical energy to the market, the problem, so far as Sacramento is concerned, resolves itself into the question, Which can

do the work cheaper, the central station consuming coal, or the transmission plant consuming interest on the additional expenditure necessary to develop the water power, and render its energy available?

Unless consolidation or other combination should occur, there is reason to believe that Sacramento is on the eve of a struggle for commercial supremacy between the two electric systems which it is so fortunate as to possess. One side is ranged on the vantage ground of abundant water power, but its forces are crippled because of the heavy interest charges that must be met; the opposing side is free from bonded indebtedness, its interest charges are light, and, if need be, by the substitution of gas engines for its present steam plant, and by effecting changes in its system of distribution, it can render service at exceedingly low rates. It is the outcome of the struggle that electrical engineers are awaiting with bated breath, but from it all cheaper and cheaper power with greater and yet greater prosperity awaits the manufacturing interests of the city.

This, then, is the good fortune that in all probability awaits the newer Sacramento.

THE OPPORTUNITIES OF ELECTRO-CHEMICAL ENGINEERING.

Electrical engineering in the fields of dynamo design and the application of electricity for lighting and motive power has become a question of detail to such an extent that little remains for the ingenuity of one wishing to make any advances along any new lines. The high frequency work of Tesla and Thomson presents wonderful possibilities, but as yet the application of high frequency transmission exists only as a possibility, and the experimenting yet to be done requires a genius of high order, aided by an unusual amount of capital. Electro-chemistry, however, is rapidly advancing along the lines of laboratory practice and technical workmanship toward becoming a true part of the engineering profession.

The reduction of aluminum by the means of the Cowles, Herault and Hall processes have already been reduced to a scientific basis. The electrolytic refining of copper has long since passed through its preliminary stages, and the great works in which thousands of tons of copper are refined every year by means of electrolysis attest its superiority over furnace refining methods heretofore in use. But, though bleaching by means of salts obtained from electro-decomposition was one of the earliest attempts of the electro-chemist, no wide introduction of the process has been made up to the present time. Bleaching salt may undoubtedly be obtained by electrolysis, but the details of the plant necessary for bleaching fabrics with complete success have not been worked out. The same is undoubtedly true of the electrical tanning of hides and the electrical production of disinfecting fluids. Gradually, little by little, we are learning what is necessary to advance these applications of electrolysis from the experimental to the commercial stage.

In general, the electrician attacking the problem is deficient in his knowledge of chemistry, while chemists of sufficient ability rarely have enough knowledge of the electrical faults in their systems. A new training is therefore needed for the engineer to enter upon the field of electro-chemistry, but to men who combine the knowledge of chemical manipulation with a thorough training in electrical engineering not only are these fields open, but a vast number of other problems are presented which await solution and promise fortune for their solver. It must have struck every man who read Mr. Keith's paper on electro-metallurgy of gold and its discussion before the British Institution of Electrical Engineers, that the paper claimed discoveries in chemistry which were but barely criticised by the eminent electrical engineers who took part in the discussion. Whether the electrical calculations were true or not depended upon the truth of certain chemical theories, the knowledge of which was wanting, and the criticisms were consequently of but little value, either as approving or condemning the process.

The most recent advances in electro-chemistry involve still more the underlying theories of chemical action. The synthesis of chemical compounds has been for many years the dream of the chemist, and, though the chemists have stated the possibilities of such synthesis, little advance has been made by any truly chemical process. Within the last few years we have been astonished by the immediate introduction of two electro-chemical processes accomplishing synthesis. The first of these is the manufacture of carborundum by Mr. Acheson. This grinding powder, which has proved itself to be superior to emery, is now so well introduced that the company manufacturing it has contracted for one thousand horse-power at Niagara Falls.

The later discovery of the synthesis of calcium carbide by means of the electric arc, while being simply an accidental discovery, nevertheless opens far wider possibilities and is the more attractive discovery to both the chemist and electrician. The simple immersion of this material in water produces acetylene gas, while recent experiments indicate that a large number of hydro-carbon compounds can be simply and economically manufactured by similar processes. Moissan, by means of his electrical furnace, has not only fused carbon and many metallic oxides, producing by these means diamonds and other gems, but has lately effected a synthesis of hydro-cyanic acid, again presenting wide possibilities to the electro-chemist.

Not only does this field of electro-chemistry present an attractive branch of research, but also the electrical generation and transmission of immense powers at low cost admits of the possible commercial application of electro-chemical processes, which up to the present time have been hindered by the necessarily expensive means of generating great quantities of energy.

A prophecy of what will be in the future of electro-chemistry would be, indeed, idle, but the indications of the field to prospective students and experimenters is right and proper. More and more the advance of the world is taking place by the applications of scientific

methods, and no field of study requires more thorough training than electro-chemistry does in the science of electricity and the science of chemistry.

ON CENTRAL STATION ECONOMY.

It may seem a difficult statement to support, but it is nevertheless true that electricians as a rulé pay too little attention to the value of electricity as a means of the transmission of power in their own plants. It has only been within a very few years that the machine shops of the electrical manufacturers have been equipped with electric motors, even where such power was daily run to waste in the testing of dynamos on lamp loads, and to-day a general inspection of our best-equipped lighting and power plants will show great disregard of the saving to be obtained by the use of small electric motors in the place of small steam engines.

Perhaps because it is difficult to ascertain the power consumed in feed pumps, blast fans, hoisting engines and other small motors, often used by a large plant in great numbers, it is taken for granted that the steam they use is only an inconsiderable quantity. But when we reflect on the fact that a ten horse-power engine, running under favorable conditions of load, will consume as much steam per hour as will be required for thirty or forty horse-power delivered by the main engine of a well-equipped plant, we are bound to come to the belief that, aside from steam leaks and pipe condensation, a number of small engines about a plant may produce a very appreciable difference in the annual coal bill. The auxiliary engines of a generating plant rarely run under favorable conditions of load, and the elements of steam leaks and pipe condensation are by no means inconsiderable items. Feed pumps and blast engines must have ample capacity for the duty required at the full load of the station, while the maximum duty is rarely if ever required, and as a consequence the engines driving them run under the worst possible condition of economy; the packing of valves and pistons being continually watersoaked are almost always in a leaky condition, while the condensation in the large steam pipes with which they must be fitted, generally amounts to much more than the steam required for furnishing power.

Aside from these actual steam losses, such connections are a continual menace to the plant itself, and in more than a few cases the breaking of an insignificant steam pipe has occasioned troubles affecting the whole plant.

Several of the best English engineers have called attention to the fact that such losses might be largely diminished by the substitution of electric motors for all kinds of auxiliary power in use about a central station, but unfortunately for the best plant economy, the idea does not seem to have taken root deeply in this country. The question as to what is to be done when the main engines are shut down may be answered in the case of a large plant, that the main engines are never shut down, and even in stations where the engines are shut down while the boilers are still under steam, it yet holds that there will be greater economy obtained from a single engine driving a generator for the various motors in use than by the operation of many steam motors.

Steam boilers, feed pumps and other auxiliary engines are time honored institutions. We know that they will do the work day in and day out, and we know that they are used in steam plants to the thousands of horse-power while one is counting on the fingers the installations of electrical apparatus for such service. Where lies the advantage and the great need for so strict an economy? Aside from the fact that every undertaking must be made to pay a maximum net income, there remains for the electrical engineer the continual exploration of new fields of service.

The economical generation of electricity may solve the perplexing problem of the power for town manufactures. Were it possible for central stations to deliver electricity at the terminals of the motors situated throughout a manufacturing district at fifty, sixty or even eighty dollars a horse-power per annum, there would be few factories in any of our cities that could afford to maintain their steam engines and boilers. Some of our present central stations are contracting for city arc lights at approximately ninety dollars per horse-power per annum, and the charge includes the interest and depreciation on the lamps, besides the expense of carbons and trimmers. But to supply a manufacturing city with power for its factories, it is necessary to generate the power much more economically than can be done by the factories with their own steam plants. In the first place, the ease of the transmission of electricity makes possible the location of the generating plant in the most advantageous position.

Condensing water and cheap coal handling may be obtained where either or both are impossible to factory engines. But though these are items of original advantage, the competition between the power from a central station and from a local plant must yield a profit to the central station which can only be assured by an unheard of economy in operation. It is in the favor of plants for the transmission of power by the means of electricity that such economies are a possibility.

Not every city is fortunately located in reference to water-power, but, on the other hand, very few manufacturing cities depending on steam power are so situated that the greatest economy of steam generation and coal handling may be practiced by the majority of power users. This admits a considerable margin of profit to a central station for the distribution of power, provided the greatest economies are practiced at the generating station. Dr. Emory has pointed out that water power is not necessarily a cheap power on account of the great expense involved in the hydraulic plant, and if the power developed by water must be transmitted to a great distance, it is unquestionable that in many cases a cheaper power could be distributed to a district from a steam generating station. This most obvious field for the transmission of energy has been little attempted. But a future advance in the transmission of energy may be profitable where electricity is generated by a steam plant, and sold to the users of power throughout large manufacturing cities.

Literature.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS, by FRANCIS B. CROCKER, Member A. I. E. E., Professor of Electrical Engineering Columbia College, and SCHUYLER S. WHEELER, D. Sc., Past President A. I. E. E., Electrical Expert of the Board of Electrical Control, New York City, etc.; 206 pages, 12 mo. cloth, 99 figures, circuit diagrams, etc. Third edition, revised and enlarged. Published by the D. Van Nostrand Company, New York, 1894. Price, $1.00.

The dynamo attendant who has for years laboriously collected bits of information about dynamos and motors, and has perchance arranged a scrap book that he may "dig up" knowledge concerning the connections of this or that machine, or that on the occurrence of trouble he may find a way to apply a remedy, will welcome the third edition of this work, the title of which tells just what it is. It is not easy to think of a disease that a dynamo or motor is heir to that is not diagnosed and prescribed for in a clear, comprehensive way, and in a manner that is satisfying. The plan of first conveying an understanding of the normal functions of machines is adhered to, in doing which numerous circuit diagrams are given, together with many illustrations and descriptions of practical detail peculiar to the dynamo room. Knowing the normal state, any abnormal condition will be readily perceived, from which is obtained the symptom of trouble that, through Crocker and Wheeler's book, will quickly suggest a cure. It is not a book dealing with generalities, in typical cases or in scientific terms. It deals only with conditions as found in the dynamo rooms of central stations and isolated plants, and, what is equally significant, it discusses these conditions in plain words, whether the theme be the proper splicing of belting, the making of efficiency tests, the uses of the equalizer bar or the problem of running alternators in parallel. Considerable space is also given to the consideration of machines requiring especial directions, such as the Thomson-Houston, Brush, Wood, Sperry and Excelsior arc dynamos, all connections, details and peculiarities of which are shown.

The clearness, thoroughness and genuine merit, together with its low cost, make the work one that should become the text book of every person who has to do with the actual care and operation of dynamos and motors.

ELECTRICITY IN PLANT GROWTH AND LIGHT IN CHEMICAL DECOMPOSITION.

BY LIEUT. W. STUART-SMITH, U. S. N.

Many experiments have recently been made to determine to what extent electricity can be utilized as an accelerator of plant growth, these experiments covering the use of earth currents which act directly as a stimulant to the plant roots, and the effect of the light from powerful arcs acting upon the stems and leaves. The results obtained by both these methods have been so fully described in the technical and daily press that only a brief mention of them will be made in this paper, the object of which is to give a probable reason for the great variation in plant growth from year to year when there is but little apparent difference in the climatic conditions, and also to offer a possible explanation of the action of light in producing chemical decomposition.

For accelerating growth by the stimulating effects of a current, the experiments have been made by placing bare wires in the ground, located in such a manner that the current, in passing from one to the other, would make considerable use of the interlacing roots, which, on account of the sap, no doubt have a considerably higher conductivity than the moist soil. The conductivity of the sap is probably much higher than that of the surrounding moist earth, owing to the many contained elements which are extracted from the soil. Tests in this direction have been made by Prof. C. D. Warner at the experimental station at Amhurst, Mass., and "roots of certain vegetables and tops of others were found to be greatly enlarged under this process. In fact, all plants were found to be stimulated by a current of certain strength. The physiological effect of electricity upon plants, although not yet definitely understood, is probably similar to that experienced by animal tissues."

If the results of these experiments be confirmed, it may point to a possible value of ordinary earth currents in aiding vegetable growth. Such currents are known to exist, and at times they become so severe as to interfere with the action of telegraph and other electric lines using grounded wires. They are particularly heavy during so-called magnetic storms, but these, being of short duration, can hardly be expected to have much effect on plant life. It is possible, however, that carefully kept records will show that over a large area during some years the earth currents may be steadily much above the normal, while during other seasons they may be much below. If this is true, an examination of these and crop records might possibly show heavy crops corresponding with heavy average earth currents, and vice versa. It is the writer's recollection that some correspondence has been found between crops and sun spots, and if this rests on good authority, earth currents may be the cause, as magnetic disturbance on the earth certainly does correspond with activity in the sun.

The favorite method with experimenters is to make use of the light from an electric arc which is known to be rich in actinic rays. Many experimenters have entered this field, and the result of their work is to prove beyond a doubt that by extending the time during which plants are under the influence of light, much can be done in the way of accelerating their growth, and even causing fantastic growths. By regulating the distance of the plants from the source of light, gradations of forcing can be accomplished, and with plants close to powerful uncovered arcs the tops can be forced to such abnormal growth that the roots are unable to supply the requisite moisture, and the plant dies. All this is the result of the action of the actinic rays in producing decomposition of carbonic acid, thus supplying the material necessary for plant formation. An obvious extension of these experiments is to provide screens which will absorb the short invisible waves in a greater or less degree, and which can be regulated in such a manner that various portions of the space under cultivation can be supplied with actinic rays in accordance with the demand as determined by examination of the growing plants.

In hot-houses or confined spaces where the composition of the atmosphere can be regulated, the supplying of greater or less quantities of carbonic acid, moisture, etc., as well as regulating the actinic rays, will permit of a much wider control, and the possibilities of control will reach a maximum, if, in addition to the regulation of light and carbonic acid above ground, the roots are stimulated to greater activity by the use of regulated earth currents as above, care being taken to provide the soil with such constituents as the various plants require in addition to the carbon received from the atmosphere. Perhaps the greatest benefit will be derived by those plants which require to be raised from the seed each year, as perennial plants which are systematically subjected to enforced growth may become finally weakened by the process. Nevertheless, if the roots can be properly stimulated to keep up the supplies needed by the accelerated top, it is possible that the strength can be main-

tained and even increased to such an extent that many times the normal size natural to the bush or plant can be attained.

This leads again to the subject to discuss which this paper was written, viz., the variation of crop growth from year to year with but very little apparent difference in climatic conditions. The experiments made confirm what has long been well known, viz., that actinic rays are requisite for plant growth, their office being to decompose carbonic acid, from which the supply of carbon is obtained. Every photographer knows that from day to day the amount of exposure necessary to make a good negative is subject to wide variation, but probably comparatively few of those who makes pictures are aware that such variation extends over entire seasons, and these for many months at a time as much as four or five times the normal exposure is necessary, while at other times, for many months perhaps, not more than one-fifth the normal exposure is required. Nevertheless, such is the case, and it is demonstrated that under conditions that are the same, as far as the eye can detect, that is, clear, blue sky, etc., the actinic power of sunlight, as received at the earth's surface, may vary as much as 1000 per cent. for periods extending over as many months as are required for a season's growth of crops. Since actinic power of light is necessary for the best growth of plants, it is at once seen such wide variations must produce corresponding variations in vegetable growth.

It is not the purpose of this paper to discuss the causes producing such variations in the actinic power of light. It may be caused by some absorbent in the earth's atmosphere, or by some nebulous mass coming between the earth and sun of such extreme attenuation as to have no effect on the longer waves of the spectrum and yet be capable of absorbing the actinic rays, or, which is more probable, it may be due to the sun itself, the light having more actinic power during periods of great activity, such as exists during the regular recurring sun spots. It was many years ago suggested by some indefatigable collector and comparer of statistics that crops seemed to bear some relation to sun activity, but no explanation was attempted. The camera furnishes means by which the activity of the light from year to year can be readily recorded, and meteorological stations would do well to make such observations a part of their regular work, and at the same time carry on a systematic study of earth currents. A study of such records might make it possible to closely predict the condition of the crops for a coming season.

Since the action of light in producing chemical decomposition is of the utmost importance in plant growth, some attempt to explain how light acts to produce such decomposition may not be out of place in this connection. Manifestly this action cannot be produced by any heating effect caused by the absorption of the light rays since the rays at the red end of the spectrum, by the absorption of which most heat would be produced, have no effect on the most sensitive photographic surface, whereas the shortest rays at the other end of the spectrum have a vigorous action in producing decomposition. In what manner do short waves act to produce chemical decomposition? If a string is vibrated in front of a properly proportioned resonator, the volume of sound produced will be magnified many times.

In the practical work of transmitting electricity over long lines by means of alternating currents, it was soon found that where a line had been built in such a manner that it was believed that 10,000 or 20,000 volts would not break down the insulation, yet the insulation did break down in a most unaccountable manner, heavy glass insulators being pierced by the disruptive action of the current. A study of the conditions showed that with a long line having the proper capacity, etc., the wave period of the line might correspond either with the fundamental wave period of the dynamo or one of the harmonics, in which case there would be strong resonance effect, and where the wave rebounded at the end of the line the electromotive force would be many times that originally impressed upon it with the result that rupture of the insulation would take place.

Now it seems to the writer that something akin to this must occur when light produces chemical decomposition and that there is a true resonance effect of sufficient power to break down the force of chemical affinity.

The atoms composing the molecules of substances have vibration periods different, perhaps, for every substance; yet in some these will correspond with the vibration periods of the shorter waves of the spectrum. Where such substances are acted upon by light, we may suppose that when the atoms reach the end of their paths and begin to return, they are acted upon by the actinic vibrations of the ether, and this, recurring with each vibration the power required to arrest the motion of the atoms at the ends of their paths is rapidly augmented until finally they pass beyond the limits of stability and, the force of interatomic attraction being overcome, the molecule goes to pieces and chemical decomposition takes place by the action of ether vibrations through the agency of a true resonance effect. This breaking down of the molecule will occur with a smaller resonance the more unstable the substance, that is, the less the chemical affinity of the atoms composing the molecule; or in other words the greater the tendency of some atoms to pass beyond the limits of the controlling attraction of the other atoms composing the molecule and within the limits of attraction of other atoms with which they more readily vibrate in unison. Stability or unstability of molecules probably depends upon the union of atoms having more or less agreement in the times and extent of their vibration, a group of atoms vibrating in approximately the same time and with the same amplitude, probably being much more stable than a group in which the atoms vibrate in very different periods with widely varying amplitudes. With a group in which the paths and periods correspond it is readily seen that the atoms may always remain close together, and thus continually exert upon each other a powerful attraction tending to hold the group together, but if the periods and paths greatly differ beats will occur, and while at one time they will be vibrating close together, after a brief period they will be vibrating at opposite extremities of their paths, and the attractive force will be very weak. At such times a small resonance effect, acting upon either the atoms of long or those of short period, would drive them beyond the range of attraction of the other and produce chemical decomposition.

If the atoms set free by the decomposition do not find other atoms with which they can vibrate more in unison, they may reunite with those from which they were liberated and reform the decomposed substance. As an example it may be noted that silver salts, when not in the presence of organic matter, will not blacken under the influence of light. In the presence of organic substances the atoms set free unite readily with some elements of the organic matter and bring free atoms in a nascent state have in themselves great decomposing power if their affinity for the elements of the organic matter is strong; *i. e.*, if, as they are projected (by resonance effect) beyond the influence of the atoms with which they were previously vibrating, they find themselves close to atoms of other molecules with which they tend to vibrate in unison.

There is probably a considerable range in the lower spectrum where the wave periods are such as to be capable of producing resonance in different substances.

It is not necessary for stability or unstability that the atoms composing a molecule should have either different periods or amplitudes of vibration as these conditions may occur with precisely the same periods and amplitudes for all atoms. This will be readily seen if we consider two atoms together at any point of their paths and vibrating in the same direction, the same distance and in the same time. They are evidently always in a position to exert a maximum attraction upon each other, and the condition is that of extreme stability. If they are together at any point of their paths and are vibrating in opposite directions, the distance apart will soon reach a maximum and the attraction will be a minimum. Such substances are unstable. If the two atoms vibrate in paths inclined to each other at any angle between these limits of 0° and 180° the stability will be greater or less as the angle is small or great. Obviously in the first case resonance will not tend to produce decomposition, yet, as the amplitudes of vibrations of all atoms will be increased, the volume of the substance will be increased or the action of the actinic rays will be to produce expansion of the mass in precisely the same manner as heat acts by increasing the amplitude of vibration and hence the volume of the mass. This can be tested by using an instrument such as Edison's tassimeter and flashing the short rays of the spectrum upon it, care being taken to eliminate the heat rays.

The wave lengths of the different parts of the spectrum can be measured, and by determining what waves are capable of producing actinic resonance in different substances it may be possible to determine the natural vibration periods of various atoms, and ultimately the dimensions of the atoms.

Another thought which came here is the possibility of determining whether all the so-called elements are in reality composed of one primary substance. If it could be shown that ether vibration of the same period produces a maximum resonance effect in all substances, it would be strong evidence that the ultimate atoms composing all substances are the same. As to the other so-called elements they may have molecules composed of primary atoms so grouped that their relations cannot be altered.

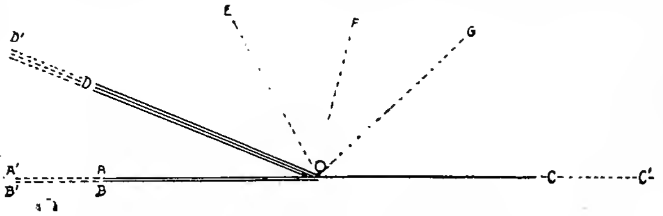
For instance, suppose some molecules were each composed of two primary atoms vibrating in unchanging relation, *i. e.*, suppose they are close together at one point of their path and maintain this distance unchanged in all points of their paths. Manifestly the attraction between them will be a maximum at all times, and this might be so strong that no outside influence could vary the distance apart. Such a combination would evidently constitute an undecomposable substance and appear as an element.

Similarly three atoms might be so combined to form another apparent element and four atoms might form a group of allied apparent elements; for instance, if the four were regularly placed with reference to each other they might constitute a molecule of oxygen, a slightly different arrangement, say two groups of two each, might constitute sulphur and another combination consisting of a group of three and one singly might constitute another element of the same family. The number of atoms and the grouping would undoutedly control the valency of the substance. Various forms of the same substance might be produced by slight possible variations of the groupings of the atoms constituting a molecule. For instance, if four atoms regularly placed with a given distance between them constituted oxygen, then ozone might be produced by a slight increase or decrease in distance apart of the atoms so as to slightly vary the attraction between them and their combined attraction on groups composing other elements. Molecules of decomposable substances would be composed of two or more such stable groups vibrating in paths which made greater or less angles with others, so that the application of a force which would cause them to move further along in their paths would produce a separation and ultimately decomposition, by bringing one or the other of the stable groups within the strong influence of some other group. Two or more stable groups united to form a molecule of decomposable substance could never vibrate parallel to each other and in the same direction, in ther words the angle between their paths could never be zero.

The ideas here expressed may be more clearly represented by means of the accompanying diagram:

Suppose O to be the origin towards which all the atoms of a simple molecule, or all the elements of a compound molecule tend to vibrate. If two atoms $O\ A$ and $O\ B$ vibrate always parallel to each other, in the same period, and with the same amplitude, manifestly the attractive force acting between them will remain absolutely unchanged whatever the period or amplitude may be. They will form an absolutely stable molecule and appear as an ultimate element. Similarly the three atoms vibrating in the direction $O\ D$ would form another absolutely stable molecule and appear as another element.

If the molecules vibrating in $O\ A$ and $O\ D$ have a mutual control of each other's motion they will form a



Electricity in Chemical Decomposition.

molecule of a compound substance, but in this case their paths must make with each other an angle $A\ O\ D$.

This compound molecule will be in stable equilibium if its constituent molecules do not vibrate beyond certain limits, say those represented by the full lines, but if a resonance effect projected them to the points A' and D' the distance between them would be increased and the mutually exerted force decreased. If no other substance was present they would return to their former stable state, when the cause producing the resonance was removed, but in the presence of other substances there would be a redistribution of molecules and new compounds be formed. Manifestly if the angle $A\ O\ D$ was very small a very considerable increase in the amplitude would but slightly increase the distance apart of the molecules, and hence produce but little diminution in the inter-molecular force of attraction. The substance formed, though decomposable by very strong forces, would still be very stable. As the angle increased the stability would become less and less until finally if the group $O\ D$ was vibrating in a direction $O\ C$, in opposition to $O\ A$, the stability would be very slight and a very small increase in the amplitude of vibration or the approach of another molecule which vibrates at a smaller angle with either $O\ A$ or $O\ D$ would overcome the force uniting $O\ A$ and $O\ D$ and decomposition would take place.

If the molecules in $O\ A$ and $O\ D$ vibrated in different periods or had different amplitudes or both, then they might vibrate in the same direction and still unite to form compound substances. An ether wave of

a certain period would then affect one more than the other and cause a resonance effect tending to break down the compound molecule. It seems manifest that the natural vibration period of all atoms and molecules closely correspond with the periods of the ether waves near the violet end of the spectrum.

Berkeley, Calif., Sept. 13, '95.

"AS OTHERS SEE US."

What we feared has come to pass. We predicted a month ago that the similarity in name and appearance of The Electrical Journal, (San Francisco) and the Electrical Journal, (Chicago) would prove "a constant source of annoyance." We pointed out to our young contemporaries that a change in name on the part of one of them was desirable or at least that they should make a geographical distinction in their titles.........[but] the Electrical Journal of Chicago manifested an acrimonious determination to retain the name selected by the new San Francisco review. This course is ill-advised and will result in confusion........."Electricity" of London reviews the first number of The Electrical Journal (San Francisco) and says: "The Editors are Dr. Perrine and Mr. G. P. Low; the aims are 'honesty, breadth and helpfulness.' Naturally, the National School of Electricity is regarded favorably." There you are; the organ of the National School of Electricity is mixed up with the new electrical review of the Pacific Slope......What could be more confusing?—Western Electrician, Chicago.

"THE ELECTRICAL JOURNAL" is a new journal published in this city. Two numbers have made their appearance, and are very creditable specimens. According to an announcement made in the August number, the name of the publication is to be changed to the THE JOURNAL OF ELECTRICITY. The Journal is edited by F. A. C. Perrine, D. Sc., and George P. Low. It is devoted to the development and exposition of the electrical interests of the Coast. The leading article in the August number is a learned and well-written article on "Steep Gradients on Electric Roads," by Lieutenant W. Stuart-Smith, U. S. N., the well-known electrical engineer of this city.—San Francisco Report.

We note the advent of The Electrical Journal pubited by our friends, Dr. F. A. C. Perrine and George P. Low, and published monthly in San Francisco. The newcomer candidly admits that "our newsy friend, the Electrical Review, is entitled to the distinction of being 'the oldest weekly'," and states as its motto that The Electrical Journal is to be known as "the newest electric cal publication in America." We wish the new venture success. Judging from the excellence of its book reviews, we opine it will pay special attention to this department.—Electrical Review (N. Y.).

The Electrical Journal, a recent publication devoted to electrical interests, came to our desk. We thank Mr. Geo. P. Low, and wish him every success. This paper should receive the support of every underwriter, for it contains matter exceptionally valuable to our professsion. Mr. Low has given able service to this branch of underwriting, and his paper will undoubtedly reflect the ability of which its editor is possessed. The subscription price is one dollar per year.—Rambling Notes, San Francisco.

Another promising publication in magazine form appears for its share of advertising patronage and to aid in disseminating electrical information through the West. The Electrical Journal is published monthly in San Francisco, Cal. It has a good appearance, and its principles, as outlined in the first issue, seem sound.—Scientific Machinist, Cleveland, O.

THE PELTON WATER WHEEL.*

The Pelton water wheel is what may be termed an impulse reaction wheel, the power of which is derived from the pressure afforded by a head of water, supplied by a line of pipe, discharged upon it through a small nozzle, the size of said nozzle being proportioned to the amount and head of water available, and to the power required. The manner of utilizing this pressure is the distinguishing feature of the invention and the secret of ts success.

The plane of the wheel is vertical, turning upon a horizontal axis, the bearings of which are mounted and fixed upon a wooden or metal frame, to which also the nozzle is attached, making the machine, as a whole, self-contained. The bearings are accessible at all times for examination and lubrication, and are easily protected from water and grit. Over the wheel, but not touching it anywhere, is placed a cover for withholding the sling of the water from the wheel, and directing it vertically downward to the tail-race, whence all waste is carried away. It has a number of iron buckets or cups fastened to its periphery, each provided with a wedge dividing the jet (which is applied tangentially) into two parts, one turning to the right, the other to the left, (shown in section in Fig. 3.), the direction of both being almost completely reversed before the water leaves the bucket. To facilitate the escape of the spent water and to utilize all of the head, the stream is usually applied to the lower side of the wheel. The object in this, as in other wheels. is to receive the water without shock, to discharge it without velocity, and to apply the energy thus liberated to turning the wheel in the most efficient manner. †

The extreme simplicity of these wheels renders them strong and durable, not liable to get out of order, and enables them to be run with a minimum of wear. Breakage seldom occurs; the wear is confined to the large shaft bearings and to the vane surfaces over which the water passes. There are no running water joints to preserve, and the nozzle is of the simplest and most efficient form, the cylindrical jet being commonly used. The path of the water in the bucket is short, reducing friction to a minimum. If the water carries abrasive materials, the effect is sometimes seen on the wetted surfaces, but the wear is slight, and never detrimental to efficiency. Then again, all the wheels above two feet in diameter have the buckets bolted on, so that one or more may be easily and quickly replaced without disturbing the installation. This is an advantage which is everywhere appreciated, especially in localities far removed from industrial centers.

The tendency of modern machine practice is to introduce direct connections between the motor and the machine to be driven, thus simplifying the parts, reducing first cost and maintenance, and economizing space. The construction of the Pelton wheel enables this to be

*Being an abstract of the report of the Franklin Institute, through its Committee on Science and the Arts, on the invention of Lester A. Pelton.

†In the Comstock mines at Virginia City, Nevada, are located six wheels, each weighing 220 pounds, developing 125 horse-power each with a stream five-eighth inch diameter, and a head of 1,680 feet. They are forty inches in diameter, are made of phosphor-bronze, and run at a speed of 900 revolutions per minute. In one of the famous Comstock mines at Virginia City, Nevada, is a thirty-six inch Pelton wheel, made of a solid steel disc, with phosphor-bronze buckets securely riveted to the rim. It is located at the Sutro Tunnel level of the California and Consolidated Virginia shaft, 1,640 feet below the surface. In addition to the head afforded by the depth of the shaft, the pipe is connected to the line of the Gold Hill Water Company, which carries a head of 460 feet, giving the wheel a vertical head of 2,100 feet, equivalent to a pressure of 911 pounds. The water, after passing over the wheel, is carried out through the tunnel, four miles in length. The wheel runs at 1,150 revolutions, which gives it a peripheral velocity of 10,804 feet per minute, or about 120 miles per hour. The construction of the wheel amply provides for the centrifugal strain given by the velocity of the water, running without load, when it would attain the enormous speed of 21,608 feet per minute, equal to about 240 miles per hour.

done in all cases where the head, which controls the speed of the buckets, is so related to the rotative speed as to give a wheel of reasonable dimensions. The minimum diameter depends, to a certain extent, upon the quantity of water to be used; if this is large, it may be necessary to use more than one jet on the wheel, or to use two or more wheels on the same shaft, to obtain the required speed. The application of several jets to a wheel does not impair the efficiency when it is carried out according to well-known rules. The cases and foundations are light and simple, there are no expensive penstocks or draft-tubes, no inconvenient means of transmission, no heavy stonework.

Turbines have a distinctive advantage under very low heads, because of the large quantity of water which they can use, but under high pressure the speed becomes excessive or destructive. A free jet or tangential wheel may run to the limit fixed by the strength of the material without injury, there being no wear except in the bearings. The construction of these wheels indicates that a high efficiency may be obtained when running with a full or reduced water supply, and such has been found to be the case. Buckets are designed for a maximum diameter of stream, without reference to the head, but the only objection to a very much smaller stream would be the disproportion of weights and friction surfaces, an ojection which is of very little practical importance. This method is adopted when the quantity of water varies, the minimum stream being often only twenty-five per cent. of the maximum. This can be done with no appreciable loss of efficiency, in strong contrast with the turbine, with its variation of twenty per cent., more or less, under varying gates.

In many cases of use in the mountains there is no need for governing devices; on stamp-mills, for instance, when such are necessary, the method used will depend on the water supply. If a liberal use of water is allowable, a nozzle is used having a ball and socket joint, which permits the stream to be partly or entirely deflected below the buckets. The centrifugal friction governor has been used to a very great extent, the balls acting on a double-geared bevel friction wheel, which opens or closes a butterfly valve.

When a constant speed can be obtained from a source outside of the wheel itself, as from an independent motor, the differential governor is available. This consists of four miter gear wheels in mesh, each forming the side of a square; two opposite gears being loose on the shaft and driven in opposite directions by pullies and belts: the remaining two running free on studs which project from a hub fastened to the same shaft. So long as the pulleys run at the same speed there will be a simple rotation of the gears on their axes; but if one runs faster than the other, the gears on the studs will be revolved bodily around the shaft. This motion, which is very sensitive, is made to open or close a butterfly valve in the service pipe. Safety stops are provided at full open and full shut, to prevent the governor from binding the valve and possibly breaking something. This method is advantageous in electric lighting, where there is a demand for close governing.

Nothing contributes so much to the prosperity of mining and manufacturing as cheap power. Scores of the largest producing and most profitable mines on the Pacifit Coast could not be worked to-day but for this, as most of our heaviest mining operations are based upon handling a large amount of low-grade ore in a most economical way. Another fact indicating the change wrought by the introduction of these wheels is the high price that low-grade mines are commanding when so situated that water power could be availed of; these mines, a few years ago could hardly be given away. Where the power developed by the wheel cannot be applied directly to the machinery to be operated, electrical transmission can cover the intervening space, and so in time these easily established links will connect many of the great industrial establishments with these water powers now by this wheel made economically available.

The remarkable efficiency of the Pelton wheel is a surprise to all who see it in operation for the first time. That a wheel so small as to almost escape observation should be capable of driving the large amount of machinery that is often attached to it is a perpetual wonder even to those long accustomed to its use.

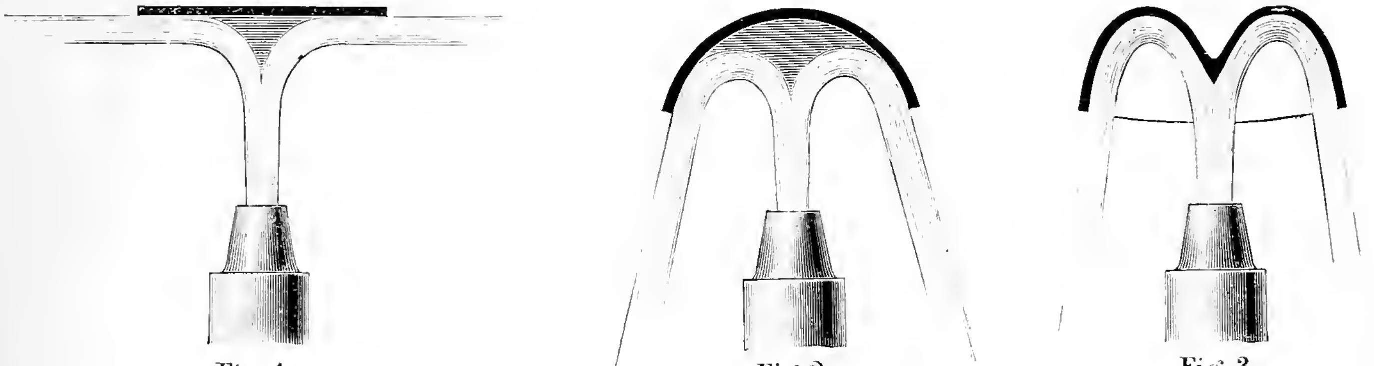


Fig. 1. Fig. 2. Fig. 3.

FIGURES 1, 2 AND 3.—ILLUSTRATING THE ACTION OF A JET OF WATER STRIKING VARIOUS SURFACES.

These wheels are made in sizes from four inches in diameter, and weighing, with case, twenty pounds, for driving sewing machines, dental apparatus, and the like, to wheels of five, six, eight, ten and in some cases even twenty feet in diameter. Wheels of such large diameter are not for the purpose of increase of power, but to reduce speed so as to make a direct connection to the shafts of the machinery they are to operate, as in the case of pumps, compressors, etc. By applying three, four or five streams to a wheel of ten to fifteen feet in diameter, from 3000 to 5000 horse power can be obtained from a single wheel under a head of 150 feet. This illustrates the extreme flexibility of the system and its application to varying conditions, units of power, speed, etc.

In considering the conditions necessary to a high efficiency in the jet wheel, it will be found that the main conditions are as follows: (1) The jet should enter the bucket without shock and flow over easy curves until its direction is reversed; (2) The surface over which the water passes should be small, to reduce skin friction; (3) The speed of the wheel should be such that the water will leave the bucket without velocity.

Fig. 1 shows the action of a jet of water striking a

flat plate at right angles. It will be seen that the water divides and shows a tendency to form a wedge of still water. This is what may be termed "dead" water, that is, water which has lost its impelling force. In a wheel having this form of vane, there is a tendency to form such a wedge on each vane at every revolution; there can be no smooth flowing of the stream, but a continual turbulence resulting in great loss of energy, and the amount of this will be greater than the loss of part of the energy contained in the water represented by the wedges. It will be seen, also, that the direction of discharge precludes a complete stoppage of the water, the highest theoretical efficiency being fifty per cent., excluding the losses from friction, turbulence etc. In the simple curved buckets shown in Fig. 2 will be found the same condition as to a wedge formation as was shown on the flat plate, the amount of water being even greater. There is, however, a reversal of the stream which allows it to be almost completely checked. This is an important advantage, as may be seen in a comparison of the efficiencies obtained.

Fig. 3 shows a third form, in which the wedge has been made a part of the bucket itself, thus avoiding the loss due to the water-wedge and to turbulence. *Impact* has been reduced to a minimum, and the bucket forms part of an *impulse* wheel. This is the Pelton, which has shown a higher efficiency than any other jet wheel, and which is now replacing the older forms. In wheels having flat radial vanes or buckets, and a tangential application of the stream, the angle of impingement varies as the vanes pass through the jet, but there is at all times an *impact*, resulting in a loss. In contrast with this is the impulse wheel, in which the water enters the vanes or buckets without shock, and is led in the proper path, there being no coercion of the water, but a smooth, regular flow. In the *impact* wheel there is a *blow struck*, while in the *impulse* there is a push.

To make such tests of this wheel as would be convincing and satisfactory, the committee charged with this investigation found to be impracticable. In lieu thereof the committee has found it necessary to rely upon the corroborative results of tests made by men esteemed by the committee as fully competent to do such work.

In the tests of this wheel made by Mr. Ross E. Browne, at the University of California, "the diameter of the wheel was fifteen inches, the width of the bucket 1.5 inch, and the efficiencies shown under a fifty-foot head were as follows:

"With a seven-sixteenth nozzle, 82.6 per cent.; with a three-eighth nozzle, 82.5 per cent. The efficiency was determined under as low a head as eight feet, still showing an efficiency of 73 per cent. It is proper to state that the wheel with which the above tests were made was constructed in the workshop of the University, and did not conform wholly to the manufacturer's standard. The size of the bucket was too small, and did not do full justice to the wheel, owing to the difficulty of shaping the curves accurately. It is claimed that tests with larger wheels have given larger efficiencies, and I have no reason for doubting the claim."

From all that has preceded, the conclusion is reached that the Pelton water wheel possesses all the advantages of simplicity of construction, economy of installation and maintenance, adaptability to extreme heads of water, of transportability, of close and sensitive automatic regulation and of high speeds, which belong to other wheels of its class that have preceded it, but that in point of efficiency it has excelled all others.

The Institute, therefore, deems the Pelton water wheel worthy of the Elliott Cresson Medal, and hereby awards the same to Lester A. Pelton, the inventor.

THE SCIENCE OF GOOD LIGHT.

Many retail stores are dark and gloomy looking, and what a contrast they are to the brilliantly lighted ones, writes Frank T. Green in the Pacific Druggist and Physician. The peculiar part is, continues the writer, that the owners of these same dark stores pay just as heavy bills for light as the former. It is the color of the surroundings that makes the great difference. The world associates dark interiors which lack richness, with gloom, and light surroundings with cheerfulness. The writer asserts there are some colors which are difficult to illuminate, foremost among which are those approaching black. A few years ago it was quite the fashion to have the fittings of stores ebonized and decorated with narrow tracings and lines of gold. A Japanese effect was aimed at, but the bull's-eye of gloom was struck. One of the most trying shades to properly illuminate is terra-cotta. It is difficult, if not impossible, for the color seems to absorb every ray cast upon it. The shadows behind the cornices are heavy ones, and even the high lights emit but a feeble glow, reminding one of reflected firelight. Such a color for a library, accompanied by rich draperies, might be admissible, but in a store it is a most trying one after nightfall. Creams, whites, light grays and pinks are always cheerful, and the shadows warm looking. Besides, with the empire patterns now in vogue, the paler tints harmonize pleasantly.

How many of us have noticed the glare of a white store at night. Every ray gets its full value, for it is reflected without absorption. Those, especially, who have dark fittings in natural wood need light floors, walls and ceilings to offset the effect. The colors should harmonize, however, and the contrasts should not be too severe.

People do not like to enter a black place at night, and in passing stores if one takes the time to observe, the bright effects can often be ascribed to cleanliness and color, and not always to the number of electric lights or gas burners as would at first seem.

ELECTRICITY vs. SOUND IN A FOOTRACE.

That electricity can easily outstrip sound in a foot race, is well known, but as good an illustration of it as was ever furnished, occurred at the time of the last powder explosion at Pinole, observes a California contemporary. At the instant when the great blow-up occurred, the railroad telegraph operator at Pinole, and at Sixteenth st., Oakland, were talking over the wire. The Pinole operator broke the thread of the conversation to rap on the key—"Powder works blown up!" When he received that the Oakland operator had felt no shock, and he thought the explosion must have been a small one, but after waiting about sixty seconds the concussion of the atmosphere came along, and it was violent enough to satisfy him that the blast was no small affair.

The American Institute of Electrical Engineers has issued a neat vest-pocket pamphlet, which has been prepared to meet the demand for information regarding the work of the Institute, and how to join it. It also contains a catalogue of membership, and its mission is for circulation among non-members to whom it will be sent gratuitously upon application to Ralph W Pope, Secretary, 26 Cortlandt street, New York City.

The appointment of Dr. F. A. C. Perrine by the Advisory Council as Local Secretary of the Institute for San Francisco and vicinity has been announced.

The Trade.

In responding to advertisements in this publication, please mention The Journal of Electricity.

AN ENORMOUS ILLUMINATED SIGN.

A feature of the Electric Carnival which excited the wonderment of visitors and the interest of electricians was the enormous sign advertising Ruhstaller's Steam Beer and which was swung across K Street. This sign contained 1010, 16 candle-power lamps; there being 505 on each side. It was fifty-one feet nine inches in length with a maximum height of twelve feet three inches,

the total weight being 2150 pounds, which it is claimed makes it the heaviest flash sign yet constructed. Considerable difficulty was experienced in effecting suitable anchorage to the roofs of the buildings supporting the sign, and the method finally adopted consisted of carrying the anchor lines to other buildings for more rigid support. The wording of the sign, which appears in the accompanying illustration, was so arranged that, by means of carbon break switches operated by an electric motor, the words appeared in their respective colorings consecutively, then flashing on the entire sign.

The contract for the construction, erection and operation of this sign was awarded to Frank Lyman, electrical contractor of 421 J street, Sacramento, whose handiwork was also shown in the construction of the decorative circuits of the State Capitol and surrounding grounds, the May Pole, The Native Sons' Bear, and many mercantile displays.

WIRING EXTRAORDINARY.

The Electric Carnival presented many opportunities for the exercise of the highest art in electro-decorative work, prominent among which were the magnificent floats designed and constructed through the efforts of the Carnival Committee. The electrical effects in the three principal pieces, viz.: "The National," "State" and "Fruit and Flower" floats, which are described elsewhere in this issue, were installed by Messrs. Scott & Black, electrical contractors of 303 J street, Sacramento. This firm is one of the leading wiring concerns of the capital city, and it is safe to state that the bouquets, sprays, wreaths and razzle-dazzles placed on the floats by them formed the daintiest and most fascinating features of the Carnival Parade.

Among the other works installed by Messrs. Scott & Black were the Arches at 7th and J streets, and 4th and K streets, the illuminated sign "Welcome," and of the mercantile displays, those placed about the establishments of Hale Bros. & Co., Hall, Luhrs & Co., Shaw, Ingram, Batcher & Co., Waterhouse & Lester and at the Sutter Club are deserving of special mention because of their artistic workmanship.

A NEW RAILWAY SUPPLY HOUSE.

Messers C. B. Kaufman & Co. have secured storerooms on the ground floor at 525 Mission Street, San Francisco, where they have started in business as a general railway supply house. The firm has in stock, ready for immediate shipment, railway supplies, both steam and electric, of all descriptions, from tie-plates and rails to trolley harps, hangers and insulated wires. Mr. Kaufman has been connected with the well-known electric railway supply firm of Reger & Atwater for some time past, and his many friends will be pleased to learn of his new departure.

A TOWER OF LIGHT.

An attractive feature of the California State Fair at Sacramento was the Tower of Light erected near the center of the pavilion by the Capital Gas Company and which is shown in the accompanying illustration. It was a substantial structure built of gas piping and contained four rows of lights as shown in the engraving, the lower one containing on one side the initials "C. G. Co.," and

on the other sides respectively, were the words "Light," "Heat," and "Power." The two middle tiers were brilliantly illuminated with Wellsbach burners and the upper tier with incandescent electric lamps. The photograph from which the illustration was taken was made by Varney, the leading Sacramento photographer, and presents an excellent specimen of night photography, the light furnished being from the tower alone.

Reports of the Month.

COMMUNICATION.

SAN DIEGO, CAL.—Chas. D. Long has applied for a franchise for a line of telephone poles and wires from Descanso to the Pine Valley Quartz Mill.

GREAT FALLS, MONT.—The Lewistown and Great Falls Telephone Company has been incorporated, with Gold T. Curtis, S. S. Hobson and J. F. Armington as trustees, and $10,000 capital.

SEATTLE, WASH.—The changing-over of the exchanges of the Sunset Telephone and Telegraph Company from multiple switchboards to the express system, which has been in progress since last May, is practically completed.

JACKSON, CAL.—A franchise has been granted the Capital Telephone and Telegraph Company for all streets, alleys, avenues and public grounds and ways of all unincorporated cities, towns and villages within Amador County.

EUREKA, CAL.—The Sunset Telephone and Telegraph Company is building a new pole line for metallic service from this place to Fortuna, Rohnerville and Alton, and the circuits to Arcata and Ferndale will be the next to be made metallic.

SANTA CRUZ, CAL.—The Popular Telephone Company has wired the city for 125 subscribers, and orders have been taken for enough more to make 200 subscribers when the new exchange opens. About 4000 feet of 50-pair lead-covered cable has been run, and Columbia instruments will be used. The installation was made under the supervision of H. N. Snyder.

LITIGATION.

SAN FRANCISCO.—In the suit of Mary L. Keller vs. the Market Street Railway Company, Justice Carroll held that a passenger must demand a transfer at the time of paying fare, otherwise the company is not required to issue same.

SAN FRANCISCO.—On August 23d the Bank of California brought suit in the Superior Court against C. C. Butler, Behrend Joost, Fabian Joost, J. A. Buck and N. Ohlandt to recover $15,000 alleged to be due on a promissory note given by the S. S. Construction Company to the San Mateo and San Francisco Railroad Company. By the latter company it was assigned to the plaintiff.

STOCKTON, CAL.—The Board of Directors of the San Joaquin County Hospital has declined to accept the Doak Gas Engines and the electric lighting plant unless the Doak Company will furnish an indemnity bond to cover any possible damages that may be recovered from the county by the Union Gas Engine Company, which has begun suit against Doak for alleged infringement of its patent.

SAN FRANCISCO, CAL.—The City and County Attorney, in response to a request from the Board of Supervisors, has rendered the opinion that such board does not hold the power to impose a municipal license upon telegraph companies operating interstate lines, but that this is not intended to apply to telegraph companies operating wholly within this State if there are any such doing business in this city.

ILLUMINATION.

HONOLULU, H. I.—The Hawaiian Electric Company, operating arcs, incandescent and power circuits, is supplementing its works by the addition of an ice plant.

CRIPPLE CREEK, COL.—J. W. Bailey has purchased two 40-kilowatt General Electric generators, direct connected to Ideal engines to be used for lighting his gold extraction plant; also an electrolytic dynamo.

WEAVERVILLE, CAL.—There are four electric lighting plants in Trinity County, viz.: At the Brown Bear Mine, Deadwood; La Grange Mine, Oregon Gulch Mountain; Cis Fse Mine, Junction City, and in Weaverville.

SALT LAKE CITY, UTAH.—The city wiring for the Citizens' Electric Light Company is practically completed, and satisfactory progress is being made at the new power house. The four boilers have been placed and the engine is now being erected.

SALT LAKE CITY, UTAH.—Two large generators have been ordered to relieve the machines of the Salt Lake and Ogden Gas and Electric Company, and which will ultimately be used in connection with the Big Cottonwood transmission.

SAN JOSE, CAL.—The Electric Improvement Company expects to have 15 miles of gas mains laid and to have a new gas plant that will furnish gas for $2 or less per thousand feet, erected and in full operation in less than a year.

MARTINEZ, CAL.—Johnson Bros. have submitted a proposition to the Board of Trustees offering to furnish fifty incandescent lights for one year for $1.85 each per month; thirty lights for six months at $2.25 each per month; seven arc lights for a year at $11 per month, or for six months at $12 per month.

CHICO, CAL.—Dr. H. H. Clark is negotiating with Surveyor McGavin for the purchase of the latter's water right on Chico creek, with which to operate the new electric light plant.

FLAGSTAFF, ARIZ.—The Flagstaff Electric Light Company, having received its franchise, has begun construction, and expects to furnish lights by October 1st. Its Directors are D. Babbitt, D. M. Riordan, Chas. Canall, T. A. Riordan and F. W. Sisson.

DENVER, COL.—A 50-kilowatt General Electric incandescent dynamo direct connected to an Ideal engine, and one 25-kilowatt General Electric generator, similarly connected, have been bought by the Northern Finance Company for the Felhauser Building.

BERKELEY, CAL.—Now that the new charter has been adopted, the Board of Trustees has more funds on hand for street lighting purposes, and will supplement the present arc lights by 32 candle-power incandescents, about 100 of which will first be placed.

SPOKANE, WASH.—J. B. Fisken has resigned the general managership of the Washington Water Power Company, controlling the Edison Illuminating Company and various street railway systems of this city, and has been appointed superintendent of the Consumers' Light and Power Company.

SAN JOSE, CAL.—The contract for lighting the city by arc lamps for the year beginning October 1st has been awarded to the San Jose Light and Power Company, its bid being $8.90 per lamp per month, against the bid of $8.94 per lamp per month submitted by the Electric Improvement Company.

SAN FRANCISCO, CAL.—The Edison Light and Power Company has reduced the prices of supplies to consumers as follows: Sixteen-candle-power incandescent Edison lamps, from 25 cents to 20 cents each; Edison key-sockets, from 20 cents to 16 cents; Edison keyless sockets, from 18 cents to 13 cents.

SAN FRANCISCO, CAL.—A new 2x400 kilowatt Edison multipolar generator, direct connected to a triple expansion marine type engine, has been installed in Station C of the Edison Light and Power Company, which now contains five 2x200 kilowatt generators and one 2x100 kilowatt generator of the type defined.

PALOUSE, WASH.—The new electric light plant will be located in the roller flour mill, where surplus water-power is available. The projectors have secured an option on the dynamos of the old plant and expect to furnish incandescent light at about fifty per cent. of the rate formerly asked.

PHŒNIX, ARIZ.—The sale of the Gardiner electric light plant to the Phoenix Light and Fuel Company has been consummated, the purchase price being $10,000. The Phœnix power house is to be enlarged and the plants consolidated and increased by the addition of new steam and electric machinery.

SANTA ANA, CAL.—The City Trustees have rejected the bid of C. M. Holmes of the Santa Ana Gas and Electric Company for lighting the city for one year, because the bid was so worded that it was obligatory upon the city to purchase the electric plant for $6,000 if the city refused to renew the contract at its expiration.

RIVERSIDE, CAL.—The City Trustees would like to bring in power for the proposed municipal lighting plant from a water-power eighteen miles distant, but do not see their way clear to do so and furnish the 125 arc lights and the incandescent system desired with the $45,000 that has been voted for the municipal plant.

VICTORA, B. C.—Mr. Hutchinson, superintendent of the new municipal electric light plant, has rendered a report on a 5-hour test of the steam plant in the station, as follows: Coal used, 1450 lbs.; coal per hour used, 290 lbs.; average horse-power developed 158.39; coal used per horse-power per hour, 1.83 lbs.; one boiler was used.

LOS ANGELES, CAL.—The Board of Supervisors has adopted an ordinance imposing a license tax on electric lighting companies as follows: Plants operating 500 lights or less, $2 per month; those operating 500 lights and less than 1000 lights, $10 per month; those operating 1000 and over, $15 per month. The above includes both arc and incandescent lights.

SAN FRANCISCO, CAL.—A committee of the Union for Practical Progress has addressed a letter to the Board of Supervisors asking that a special election be held to determine whether or not the people should own their own water works, gas works and electric lighting plants, either by buying the existing works from present owners at an appraised valuation or by constructing new works.

FLAGSTAFF, ARIZ.—This place is being wired for electric lights, and the new plant will be installed in the old school house as soon as the engine and dynamo arrive from the East. Incandescent lighting service will be rendered on "flat" rates of $1.10 per month for 11 o'clock lamps and $1.50 per month for lights burning until 1 A. M.

SANTA ANA, CAL.—The Santa Ana Gas and Electric Company proposes to move its plant at once from this city to Olive, where water power is available, provided it receives the contract for lighting the city with forty-arc lamps. It will require about 50,000 feet of wire to "locate" the new lamps, and about 80,000 feet to connect with Olive.

San Francisco, Cal.—The Pacific Coast office of the Westinghouse Electric and Manufacturing Company reports the sale of the following apparatus during the month: 1 60-K. W., A. C. generator with switchboard, apparatus and converters complete; 1 20-light arc plant complete; 1-2½ horse-power, 125 volt generator; 1 60-light, 125-volt generator; Isolated meter orders aggregating 610 lamps.

Forest Grove, Or.—The commissioners appointed to prepare estimates of the cost of buying the electric light plant and putting in wells and pumps to be operated in connection with it, have reported that the total cost of the proposed improvement will be $30,000. The cost of the electric light plant complete is estimated at $12,000. The report was adopted by the Common Council, which at once passed an ordinance calling for an election to vote upon the issuance of city bonds to cover the proposed expenditure.

Spokane, Wash.—The Consumers' Light and Power Company having been awarded a franchise by the Council over the Mayor's veto, has ordered the entire plant for its new electric light and power system, which will cost about $100,000. Contractors are at work blasting out for the foundation of the new power house, which will be situated at the west end on the north side of the island to which the flume under the Washington street bridge will be extended. The monocyclic system is to be used, and it is expected that service will be given before the close of the year.

TRANSPORTATION.

Auburn, Cal.—Messrs. Hartley and Reynolds have secured the franchise previously described for an electric road.

Modesto, Cal.—The Herald calls attention to the advisability of building an electric railway from this city to Coulterville.

Santa Barbara, Cal.—The Santa Barbara Street Railway Company is rebuilding its Garden-street horse-car track for an electric line.

Los Angeles, Cal.—The Kuhrts street line of the Consolidated Company was opened on August 21 for traffic and the running of cars.

Alameda, Cal.—The Alameda Electric Railway Company is having constructed a 2800 gallon sprinkling car, for which salt water will be used.

Portland, Or.—C. E. Smith, Graham Glass and others have secured a franchise for an electric road on First street over the present horse-car line.

Sacramento, Cal.—An application has been filed for a franchise to carry "fruit, vegetables and other freight" over the electric line on V street.

Oroville, Cal.—The project of building an electric road between Oroville and Butte City to Palermo and Biggs is being revived by Messrs. Hatch, Rock and Treat.

Phoenix, Ariz.—Surveying, grading and cross sectioning is being done on the new electric line that will run from First and Washington street to Dennis and Brill's Additions.

Oroville, Cal.—Newspapers are advocating the building of an electric road to run from Oroville to Palermo, thence across the river, passing through the large orchard tracts to Biggs, and then Gridley.

San Bernardino, Cal.—The Pacific Improvement Company (Southern Pacific Company) has bought the Southern California Motor Road, running hence to Riverside. The purchase price was $167,100.

Alameda, Cal.—In order to equalize the wear on car wheels from curves, the Alameda Electric Railroad sends each car on the main loop one way around the circle one day and the reverse during the next day.

Chelan, Wash.—It is stated that J. F. Baker, of the First Chelan Bank intends to build an electric railway between the foot of Lake Chelan and the Columbia river. The dynamos will be driven by water power.

Castle Rock, Wash.—The Mount St. Helens Railway Company has been incorporated to build an electric railway from here to the mining region of Skamania county. Milton Santee, B. A. Deetz and L. G. Biglow are the promoters.

Redlands, Cal.—Business men are agitating the question of calling an election for voting bonds for the construction of an electric road from Smiley Heights to the Lugonia School, with a branch line up Citrus avenue for two miles.

Redlands, Cal.—A scheme is on foot to consolidate the street-car systems of San Bernardino with that of motor roads leading to the principal resorts of the valley, and convert the whole into electric roads. Power can be cheaply obtained from the Redlands Electric Company, and negotiations to that end are now in progress, with strong probabilities of complete success.

Oakland, Cal.—E. P. Vandercook has secured a franchise for an electric road from East Oakland to the county line beyond Livermore, via Haywards and Dublin, and with a spur to Pleasanton. The line will be thirty-three miles in length, which is twelve miles shorter than the present steam route to Livermore, and the maximum grade will be 5 per cent. It is stated that construction will be begun within sixty days.

Oakland, Cal.—Engineers are surveying the route of the proposed Vandercook electric line from Oakland to Livermore, and it is stated that graders and tracklayers will be at work by October 1st. Practically, all rights of way have been secured and the maximum grade will not exceed 6 per cent.

San Diego, Cal.—Geo. B. Kerper, purchaser of the cable road and who proposes to convert it into an electric system, expects to erect various places of amusement at the Pavilion on University Heights. Power will probably be purchased from the San Diego Gas and Electric Light Company.

Concord, Cal.—The construction of an electric railway over the Piedmont hills to Walnut Valley, and thence along the loop connecting with the California and Nevada Railroad, is promised by Gen. J. A. Williamson, of Washington, D. C., who with his associates owns 14,000 acres of land in the Moraga tract, which the proposed road will open up

San Francisco.—J. B. Stetson, Lovell White and others interested in the North Pacific Coast Railway have had surveys and estimates made for the construction of a railroad, to extend from Mill Valley station in Marin County to the summit of Mount Tamalpais, a distance of about four miles. The road will probably circle the mountain.

Los Angeles, Cal.—D. M. McGarry has applied for a franchise for a new street railway to be known as the Los Angeles Belt Railway, which will start at Seventh and Broadway and going east to San Pedro, south to Ninth street, east across the river to Boyle avenue, North to Chicago, north to Brooklyn, west to Bridge, west to Aliso, west to Los Angeles, south to First and San Pedro and west to the starting point.

Los Angeles, Cal.—The Los Angeles Traction Company commenced operations on September 1st by opening its electric road running from the Santa Fe Depot at La Grange Station up Third street to Hill, to Eighth street, to Pearl, to Eleventh, to Georgia Bell, to Sixteenth, to Bush and to the city limits at Hoover street, making a distance of about four and a half miles.

Los Angeles, Cal.—The Board of Directors of the Pasadena and Los Angeles Electric Railway has accepted the property from Contractor Clark, and has paid him for the same an amount in the neighborhood of $400,000, in stocks and bonds of the Company. When its extensions are completed the road and its connections will extend from a junction with the Mt. Lowe road to Santa Monica.

Santa Barbara, Cal.—An eighteen months' franchise has been granted to the Santa Barbara Consolidated Electric Railway Company, and N. F. Ashton states that work will be begun at once on the new electric road. It is stated that as the management was obliged to wait until the preliminaries required by law were complied with under the fifty years' franchise, construction could not be begun for some time to come; hence to hasten the beginning of operations the short-term franchise was granted by the Common Council.

Portland, Or.—S. Z. Mitchell, W. T. Nelson and Fred V. Holman have incorporated the Portland Western Railway Company, to acquire and operate railway lines as follows: the railway formerly owned by the Barnes' Heights & Connell Mountain Railway Company; a railway having its termini at Portland and Hillsboro; a railway beginning at Mount Cavalry cemetery, near Portland, and terminating at Hillsboro; to build railways in any town or city of Oregon; to acquire and operate telegraph and telephone lines and power houses.

Los Angeles, Cal.—The Los Angeles Consolidated Electric Railroad was sold on August 19th to Captain A. M. Payson, manager of the Pacific Rolling Mills, as representative of the holders of $1,500,000 of bonds, or one-half of the face value of the issue. There were two bids. General Manager Fred. W. Wood states that the new owners will spend between $250,000 and $500,000 in improving the system. The entire plant will be operated from one station, which will necessitate the placing of additional boilers, engines and 1000 horse-power direct connected generators. The capacity of the plant will be from 2500 to 3000 horse-power. None of the existing lines will be abandoned, but all cable lines and the Ninth street horse-car lines will be equipped with electric traction, which will do away with the three cable power-houses now operated. The reconstruction of the system has been begun, and will be prosecuted diligently.

San Francisco, Cal.—In changing the Union street cable system, the tracks on Jackson and Washington streets are to be used jointly by the Market street Railway and the Presidio and Ferries Railway (Union street cable line), and the cost of reconstruction will be divided between the two corporations. The Market Street Railway Company, after having equipped the Post street cable line and the Montgomery street horse-car line with the trolley, will operate these lines as a continuous line, reaching the ferry over the Washington and Jackson street roadbed. The Union street cars will take power from the Market street system. The Jackson and Washington street branch will be the first portion of the Union street line to be equipped with electricity, after which will follow the main cable line on Union street to the Presidio, and then to the Harbor View extension, which is at present operated as a steam road.

TRANSMISSION.

REDLANDS, CAL.—The use of electric motors for operating well pumps is becoming very general in this vicinity.

RIVERSIDE, CAL.—Dr. Lyman Gregory has made a verbal offer to furnish water power from the San Jacinto Mountains to operate the proposed municipal electric lighting plant.

SAN BERNARDINO, CAL.—Rev. Boren, Jr., and H. T. Shirley have filed an appropriation of 7000 inches of water from the Santa Ana River for the purpose of developing power for an electric power house.

BUTTE, MONT.—An English syndicate has purchased the Clipper group of mines and will put in an electric power plant at Pony and transmit the power to the mine, where a 200 or 250-stamp mill will be erected.

FRESNO, CAL —The San Joaquin Electric Power Company has secured a franchise for its pole lines in this city in consideration of supplying to the city, free of charge for ten years, two 2000 candle-power arc lamps.

MESA, ARIZ.—A. J. Chandler, of the Consolidated Canal Company, will have 600 horse-power in electric power ready for delivery in Mesa, shortly. The water power will be obtained from a bluff one and one-half miles from here.

REDDING, CAL.—Geo. P. Himes, acting for Wm. M. Fitzhugh, of San Francisco, has located two water rights at the junction of the Pitt and McCloud Rivers, and states that it is proposed to erect thereat a plant for electrical transmission of power.

NOGALES, ARIZ.—The Boleo Company, operating extensive copper mines at Santa Rosalia, Lower California, is installing an extensive General Electric plant for lighting its works, and running all its machinery. The plant is being forwarded via Guaymas.

PRESCOTT, ARIZ.—Articles of incorporation have been filed by the Arizona Water Storage Company, formed for the purpose of developing water to be used for irrigation, mining, power, etc. Capital stock, $5,000,000. Incorporators, B. Burr, L. Marchant, Wm. E. Hazeltine.

LOS ANGELES, CAL.—Chas. Storey, Engineer of the City Hall, has rendered a report to the Board of Public Works concerning an electric lighting plant for the City Hall. The building should be re-wired, and a 500-light dynamo with additional steam equipment will be necessary.

SALT LAKE CITY, UTAH.—The copper wire for the Big Cottonwood transmission of seventeen miles to this city, and consisting of 214 miles of wire in three sizes, has been made by the John A. Roebling's Sons' works in Trenton. The total weight of this shipment is 218,000 pounds.

VISALIA, CAL.—The surveyors of the Kaweah Electric Power Company have finished the location and cross section of the ditch from the Kaweah River to the site of the proposed plant, but some time will be required to make the necessary maps, diagrams and calculations before ground is broken.

PETREPOLIS, BRAZIL.—The local electric lighting company has increased its plant by the addition of a 120-kilowatt General Electric alternator and Pelton water wheel. The present plant consists of three 120-kilowatt direct connected equipments, hence the total capacity when the new machine has been placed will be 420 kilowatts.

SANTA ANA, CAL.—The action of the Board of Trustees, in calling a special election to vote on a proposition to incur a bonded indebtedness in the sum of $18,000 for the erection of a municipal electric lighting plant, has brought out a proposition from C. M. Holmes offering to sell the entire electric light plant of the Santa Ana Gas and Electric Company for $6,000.

PARK CITY, UTAH.—The drainage water from the Ontario Mine, which has for years been a great burden, has been utilized for an electric lighting plant, and now drives a 3-phase 65-kilowatt generator by means of a Pelton water wheel. The current is conveyed to this city, a distance of three miles, and is used for lighting the company's mills and mine works.

SALT LAKE CITY, UTAH.—The Salt Lake & Ogden Gas and Electric Light Co. proposes to furnish arc lamps for street lighting at the following rates: Fifty to seventy arc lights for two years contract, $11 per light per month; three years, $10.50; for 100 arc lights two years, $10.50; three years, $10; five years, $9.50; for 150 arc lights, two years, $10; three years, $9.50; five years, $9.

SANTA ROSA, CAL.—Local capitalists are considering a transmission project by which electric power will be delivered here from a canyon forty feet higher than the Russian River, and which is situated near Healdsburg. The plant, it is estimated, will generate from 2000 to 5000 horsepower, and it is expected that with additional turbines and canals running out of the initial dam at least 8000 horse-power can be derived.

FRESNO, CAL.—Between 150 and 200 men are at work for the San Joaquin Electric Company on the North Fork. The Canal will be completed by October 1st, and the flumes are about finished. The reservoir will probably be finished by October 15th, and work on the pole line will be begun as soon as the poles arrive from Mendocino County. J. S. Eastwood, chief engineer of the company, states that the plant will be in operation earlier than February.

SANTA CRUZ, CAL —It is announced that Fred. W. Swanton, manager of the Santa Cruz Electric Light and Power Company, has made terms with Henry Cowell for the purchase of his water rights on the San Lorenzo River, and that an electric power transmission will be placed, if sufficient co-operation from the citizens can be secured. Measurements taken show that 400 horse-power is available during August, and for six months in the year the water-power of the river is equal to 1000 horse-power. The length of transmission is three and one-half miles.

NEVADA CITY, CAL.—One hundred men are at work on the flume of the Nevada County Electric Power Company, and are placing therein from 25,000 to 20,000 feet of lumber per day. All poles and cross arms are on the ground, and, with the line, will be erected at once The generator has been shipped from Pittsfield, Mass., by the Stanley Electric Manufacturing Company, and, without doubt, the plant will be finished as previously announced. The pole line will run from the power house to Sargent's ranch, thence to W. G. Richards' ranch, and from there to the Deer Creek mines, thence to Town Talk and on to Grass Valley. A branch will be run up Deer Creek to supply other mines in that locality.

FRESNO, CAL.—The reservoir for the San Joaquin Electric Power Company will consist of a natural basin covering eight acres, so conditioned as to necessitate the building of a dam on one side only, which can easily be done by throwing up an embankment twenty-three feet high and ninety feet wide at the base, and twelve feet in width at the top. The reservoir thus formed will contain 28,000,000 gallons, and will be at an elevation of 1410 feet above the power house. Three General Electric three-phase generators of 340 kilowatts each, and each being direct connected to a Pelton water wheel, will be used, and on each shaft is to be placed a 6000-pound fly wheel to act as an auxilliary for the governor, which is to be of the Pelton differential type. The dynamos will deliver current at 700 volts, which will be transformed up to 11,000 volts, and transmitted to Fresno, thirty-four miles distant, with a loss of ten per cent. Six No. 3 B. & S. bare copper wires will be used, supported by forty-foot redwood poles, 12x12 at the base, and 6x6 at the top, standard double petticoat porcelain insulators being used. The sub-station will be located adjoining the Sperry Flouring Mills in Fresno. The entire plant, which includes seven miles of ditching and considerable flume work, will cost not to exceed $200,000, and it is claimed will be in operation by February 1st, 1896.

MISCELLANEOUS.

LOS ANGELES, CAL.—The new City Jail, soon to be erected, will contain quarters to be used as the operating room for the Police Patrol system.

MARE ISLAND, CAL.—The Boudreaux dynamo brush, or its equivalent, is considered as the standard in specifications for supplies issued by the Navy Department at this place.

SAN JOSE, CAL.—Bids for an electric elevator proposed to be placed in the City Hall were received from the Crane Elevator Company of Chicago, and the Cahill & Hall Elevator Company of San Francisco, the figures being $27,000 and $29,090, respectively.

OAKLAND, CAL.—Charles F. McDermott, residing at Eighth and Center streets, is perfecting an electric submarine torpedo, the invention of Dr. Gross of Chicago, and which is claimed to be actuated and exploded by electrical means. A public exhibition is promised soon.

PASADENA, CAL.—Articles of incorporation of the California Light and Fuel Company have been filed. Its object is to acquire, construct, operate, sell and otherwise dispose of gas works, gas, electric lights, fuel and power works, etc., and to acquire and dispose of water. Principal place of business, Los Angeles. Directors: T. S. C. Lowe, J. M. C. Marble, L. P. Lowe, W. G. Cochran and H. C. Brown. Capital stock, $300,000.

SEATTLE, WASH.—Arrangements have been entered into between the various electric companies whereby three-fifths of the poles on the principal streets will be taken down and removed, and only the 60-foot poles of the Union Illuminating Company and the 80-foot poles of the Sunset Telephone and Telegraph Company will be allowed to remain.

R. M. WOOD CO. PRINT, 314-316 BATTERY ST., S. F.

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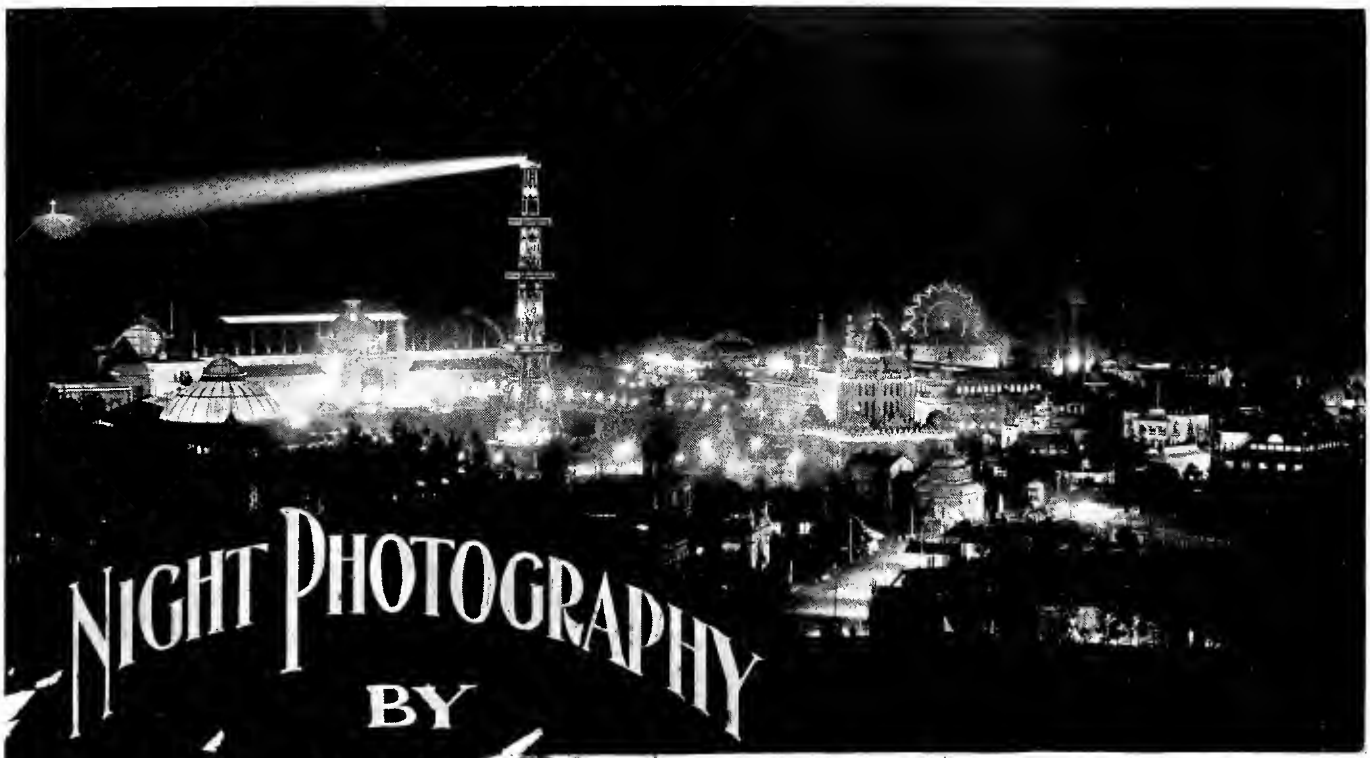


Night Photography by Electric Light

By Jos. F. Mullander and Sidney Sprout.

AN EDITORIAL which appeared in a recent number of the Journal of Electricity complained that without doubt the thousands of spectators who found much to admire in the elaborate display of lighting effects witnessed during the Electrical Carnival Night pageant at Sacramento, would regret to learn that "despite the efforts of several local photographers, there is not to be obtained a single illustration of even a single float that would make a creditable appearance, or that is worthy of reproduction."

This is a situation that excites but little surprise in view of the paucity of information concerning the taking of night photographs by aid of the electric light, and it does not follow that the inability of a photographer to picture night effects is a reflection against his professional ability for many reasons, foremost among which is, of course, the necessity for experience in this work, and, above all, a perfect co-operation of effort between the photographer and the electrician. It is the purpose of this article to give, as far as is possible, such details of practical experience as will enable work of the character defined to be undertaken intelligently by any pains-taking photographer; but success cannot be attained, nor can the results herein portrayed be accomplished, without perfect unanimity and accord of action on the part of both the photographic and electrical interests.

It is a matter well known in photographic circles that night photography did not become an established art, so far as the perfect delineation of high lights and obscure details are concerned, until the spring of 1894, when the night photographs of scenes of the California Midwinter International Exposition were taken by I. W. Taber, the San Francisco photographer, and it was at the hands of the writers of this article — one of whom is the chief view artist of the photographer named, the other being the Assistant Electrical Engineer of the Midwinter Exposition, that the results herein given were accomplished.

The idea of making exhaustive researches in the

sphere of night photography by electric light was due to the desire of the Manager of the San Francisco Examiner to develop a new and striking feature in the way of illustrating the portfolio of views of the Midwinter Fair that was then under preparation by that paper. The first efforts made in the way of night photography were far from satisfactory, as has been the experience of every photographer that has ever attempted work of this nature, and the discouraging results may be summed up in the statement that the high lights caused halation of the plate to such an extent that all detail was lost. Composite photographs taken instantaneously by daylight, but with under exposure, and then exposed again by night from the same sitting, were then experimented from this plate were not genuine, and the firm determination to secure bona fide photographs that would be absolutely free from fraud of any kind, led to the suppression of the prints, and none were ever distributed.

It soon became evident that original research alone could solve the problem, and an analysis of the situation led to the conclusion that it would be necessary to so time the various features of the subject that all details would be given equal exposures, or, in other words, that the features of the subject should be graduated into lights and shades, varying from high lights to obscure details, and that different periods of exposure should be made for each such feature, so that the effect on the plate would be the same as though all features were lighted in

Figure 1—A View of the Tower from the Main Arch of the Agricultural Building, Midwinter Fair, Illustrating the Impracticability of Photographing a Beam of Light with a Wide Angle Lens. (Copyright 1894, by I. W. Taber.)

on with no better success, and the photographs thus derived, one of which is shown in Figure 4, bore the unmistakable marks of "faking." In this photograph an instantaneous exposure was made about 5 o'clock in the afternoon, when the camera was left standing until 9 o'clock P. M., and then exposed for the illuminated effects for 15 minutes. No assistance was rendered in the electrical department in the way of turning off lamps or regulating the direction of the search light, but as the latter would form an indispensable feature in any night photograph of the Court of Honor, the beam of the search light was "faked" on to the negative by means familiar to every photographer. The general aspect of the photograph is one of twilight, just after the starting up of the lighting circuit, but the knowledge that prints

perfect equality. It was at this point that the services of the Electrical Engineering Department were brought into demand, and work was commenced on a basis that is believed to have been new and entirely original. All photographs of the Midwinter Fair were taken on Seed plates No. 26, that varied in size from 8 x 10 inches to 18 x 22 inches. No non-halation plates were used, except experimentally, as it was found that ordinary single coated plates are far superior to the non-halation plates, for the reason that the latter will not bring out details to a satisfactory degree. Both wide angle and rectilinear lenses, as will appear, were used, and throughout all the work, almost without exception, the camera was operated with an F16 stop.

The successful development of plates of night photo-

graphs can only be accomplished through the careful use of a solution of red prussiate of potash to reduce the halation wherever necessary. This solution consists of the following ingredients: Red prussiate of potash, ½ ounce; hypo, 2 ounces; water, 16 ounces. The action of this solution is analogous to that of planing a board, and if it is flooded over an entire plate it will reduce the film proportionately. To check halation it is applied to the parts affected with a bit of cotton, which cuts away the high lights of the film, and when these high lights have been reduced sufficiently, further reduction must be checked by putting the plate to wash in water. Halation may often be checked if not prevented while developing the plate by application of a solution of bromide of potassium, consisting of one part of bromide to 10 parts of water. When it is noticed that posure the high lights spread, increasing in size with the increased length of exposure, forming halation that becomes impossible to reduce. With arc lamps the rays are sometimes so intense as to actually burn holes through the films, possibly owing to the focusing of its heat-rays, as in a sun-glass, and to treat such troubles is manifestly impossible, as there is no film to be affected. An occurrence of this nature is shown very prettily in the view of the State Capitol Building, as illuminated on the 9th of September last, which is reproduced in Figs. 6 and 7, from a photograph taken by Mr. A. Peterson. In this a Seed 27 plate was used, and the first illustration shown was printed from the plate as it appeared after ordinary developing, and the second illustration is from the same plate, after having been treated with red prussiate of potash for the

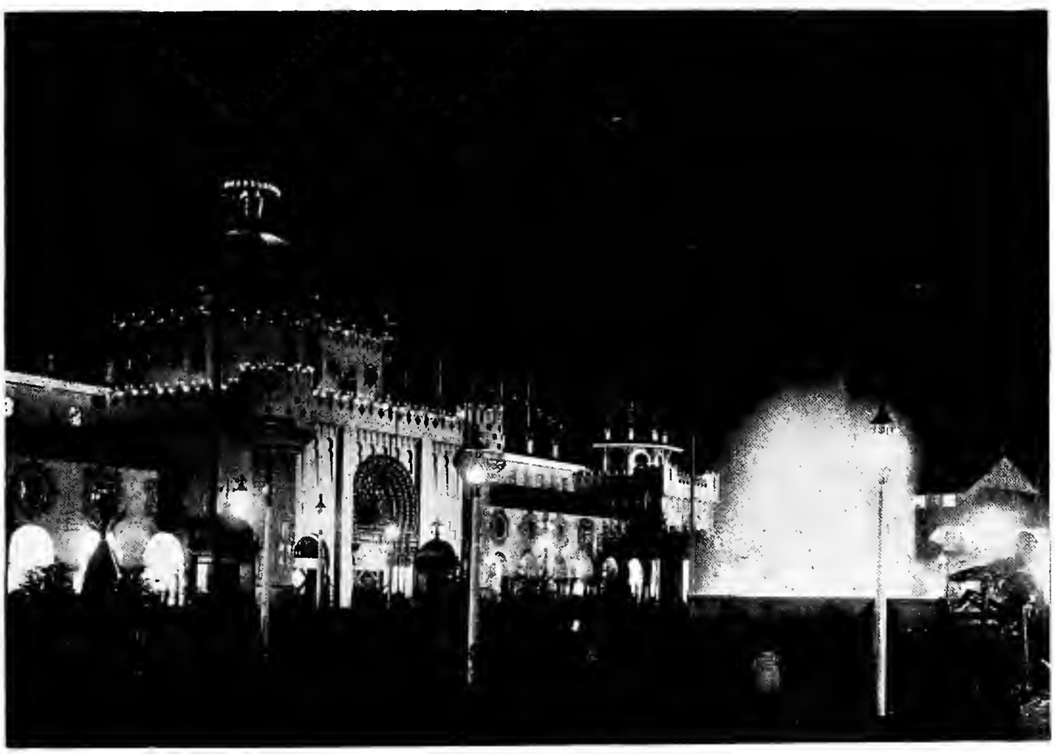


FIGURE 2—THE LIBERAL ARTS BUILDING, ELECTRIC FOUNTAIN AND DOME OF THE AGRICULTURAL BUILDING, MIDWINTER FAIR. (Copyright 1894, by I. W. Taber.)

certain lights are coming up too sharply on the plate, the touching of these parts by a bit of cotton wet with the bromide solution will check the development. An illustration of the effectiveness of this may be seen in the photograph from which the illuminated caption at the head of this article was taken, in which the lights from the interior of the Vienna Prater were coming up so strongly as to lose all details of the building, but through the prompt use of the bromide solution the development of the high lights was checked with the satisfactory results shown.

In photographing high lights the tendency is to turn the film into a perfectly hard, black substance, from the excess of light, just as nitrate of silver, when exposed to the sun, will turn black. Under proper exposure the film should turn only to a gray color, but with over-exposure purpose of cutting down the high lights. The exposure was of 2½ minutes' duration, which resulted in a severe burning of the plate about the arc lights in the dome, but it is evident that this has been very successfully reduced, except at the point of focus of the heat-rays of the arc-lamps, which, as stated, have burned holes through the films. It would be difficult to obtain a more satisfactory photograph without the assistance of the electrician controlling the lights.

An illustration showing forcibly the futility of endeavoring to accomplish night photography without the assistance of the proper parties controlling the lighting effects is given in Figure 12, which is a reproduction from a photograph taken of an illuminated arch thrown across Market street, San Francisco, last Fourth of July. In this instance an exposure of 20 minutes was made

with the stop wide open, and the plate was not treated in any way. The lamps upon the arch were of different colors, which explains the varying degree of brightness. The street traffic was perhaps larger than is usual on evenings, but of course does not appear distinctly on the photograph, even though a 26 plate was used. The streaks running along in the center of the street are from the signal lights of the passing cars, while the bright, continuous streaks are from the headlights of passing cars. These, of course, could have been prevented by capping the camera during the passing of each car, but it was deemed advisable, for the sake of illustration, not to interfere with the continuous exposure.

A similar experiment in night photography is given in Figure 11, showing a canopy of incandescent light operated during the recent water carnival at Santa Cruz, Cal., together with fire works. This exposure was started at 9:30 P. M. and stopped at 9:50 o'clock, when all incandescent lamps were turned off, but later in the evening the camera was uncapped and exposed for 30 minutes during a display of fire works. The halation appearing was caused by the calcium lights being turned directly upon the camera, and no efforts were made to remove the rings thus formed.

Reverting to the Midwinter Fair, in order that the proper exposure may be given to bring out each feature of every subject, regardless of whether such feature consisted of high or low lights, the plan was adopted of issuing orders to the dynamo room to start up or shut down specified exterior lighting circuits at such times during the evening as had been predetermined. The services of the electrical department thus became indispensable, and the first view taken after these were secured is reproduced in Figure 3, showing the Administration and Agricultural Buildings, and with the search light on the Observatory on Strawberry Hill. In addition to the usual lights, the buildings and the tower were illuminated for five minutes each by the small search light placed in the turret of the Mechanical Arts Building. The time of exposure was as follows: 9 P. M., exposure began; 9:01 P. M., arc lamps shut off; 9:15 P. M., tower lights shut off; 9:30 P. M., camera capped — giving a full exposure of 30 minutes for the buildings, incandescent and search lights.

The night view of the Liberal Arts Building, shown in Figure 2, was taken with the following exposures: The building and decorative incandescent lamps, one hour; search light on the building, fifteen minutes; electric fountain, five minutes; arc lamps, one minute.

FIGURE 3—THE COURT OF HONOR AND THE ADMINISTRATION AND AGRICULTURAL BUILDINGS OF THE MIDWINTER FAIR, WITH SEARCH LIGHT THROWN UPON THE OBSERVATORY ON STRAWBERRY HILL. (Copyright 1894, by I. W. Taber.)

In rather painful contrast to this illustration is that presented in Figure 5, which is a reproduction from an amateur effort of night photography with the same subject. This merits criticism from many points, but clearly all detail was under exposed, while the high lights were over exposed. Again, it is evident from examination of the lower right hand corner of the photograph that the developer was not flowed evenly over the plate, and that the portion of the plate which evidently was omitted from the initial flow shows better detail than the main portion of the plate. This, in turn, indicates over-development — as over-development always brings out halation it makes the hard lights harder. The severe

burning given the plates by the arc lamps has caused such halation that no reduction could have saved them.

Here may be mentioned the fact that a peculiarity of negatives produced in photographing arc lamps are the bright rays or streaks of light emanating therefrom, and

FIGURE 4—A COMPOSITE DAY AND NIGHT PHOTOGRAPH OF THE SUBJECT PRESENTED IN FIGURE 3.—A suppressed "fake l" photograph. (Copyright 1894, by I. W. Taber.)

which are always of the same inclination. No satisfactory explanation of these rays has been advanced, but the writers believe that inasmuch as the camera will reproduce details that the eye cannot detect, these rays have an actual existence but are not sensible to the human eye. By treatment of the plate they may be considerably reduced, but not eliminated, provided the plate is not too far over-exposed.

The first night photograph taken was that reproduced in Figure 8, the subject being the Tower, the Court and the Manufacturers' Buildings, which was given an exposure of thirty minutes under ordinary conditions — that is, with all lights, both arc and incandescent, operating as usual and the search light playing in all directions. In this connection it may be well to state that the favorite subjects illuminated by the search light were the simple cross on Lone Mountain, the Prayer-book Cross, and the Observatory on the top of Strawberry Hill. In this instance, the Cross on Lone Mountain formed the subject most appropriate to the photograph, and fortunately it suited the humor of the man controlling the search light to illuminate this cross more than the other subjects. Upon developing the negative, however, rays of light extended in all directions, but these, with the exception of one ray in the direction of Strawberry Hill, which the photograph shows faintly, were cut down in the manner hereafter described.

It is clear from an analysis of the photograph, if not of the illustration, that the high lights were so strong that all of the fine detail of the buildings and grounds were practically lost, as were also all of the geometrical forms which were outlined in incandescent lamps on the tower. To have made the exposure proper to avoid halation would have been to lose all of the details about the buildings, and conversely, in order to bring out the details in the buildings and grounds, halation resulted, as is evident.

The beauty of the view presented in Figure 1, showing the tower from within the main arch of the Agricultural Building, was noted towards the close of the Fair, and several attempts were made to photograph it, but none of which, even the one here reproduced, was perfectly satisfactory. The conditions presented were trying in that the subject contained objects both near and distant, which afforded considerable difficulty in focusing, and necessitated the use of a wide angle lens. This alone would not have been a material difficulty were it not for the fact that we have thus far found it impossible to photograph the beam of a search light when using a wide angle lens, the reason probably being that the rays are so diffused as to dissipate their actinic effects. The night on which this photograph was taken was exceptionally favorable in that the atmosphere was sufficiently hazy to bring out the beam of the search light very strongly, but despite this it was but faintly brought out in the photograph. The interior of the arch was illuminated by two arc lamps, and the times of exposure are as follows: 9 P. M., camera uncapped; 9:10 P. M., arc lamps extinguished; 9:15 P. M., the arch arc lamps extinguished; 9:30 P. M., tower "blinkers" extinguished; 10 P. M., tower incandescents extinguished; 10:30 P. M., camera capped, after giving the beam of the search light an exposure of one and a half hours. No more striking example of the inability of a wide angle lens to photograph a beam of light can be given than that shown by comparison of Figures 1 and 3. The photograph from which Figure 3 is reproduced, and which was taken with a rectilinear lens, was exposed thirty minutes, while

FIGURE 5—THE LIBERAL ARTS BUILDING AND ELECTRIC FOUNTAIN UNDER ORDINARY EXPOSURE, ILLUSTRATING THE BEARING OF OVER-DEVELOPMENT UPON HALATION. (Copyright 1894, by J. N. and D. Creighton.)

the photograph shown in Figure 1, taken with a wide angle lens with a superior beam of light, was exposed for one and a half hours.

The superb photograph from which the caption of this article was made, and which shows a general night view

of the Midwinter Fair grounds, was taken from Strawberry Hill, the exposure being started at 9 P. M. From previous observations it has been found that a considerable portion of the Fair grounds, particularly that of the Midway nearest Strawberry Hill, would appear as excessively lighted or not lighted at all, according to whether the lights therein were turned on or off. In the former instance halation would not only destroy all detail, but would ruin the photograph, and as the bringing out of this portion of the Fair grounds was desirable,

FIGURE 6—THE ILLUMINATION OF THE STATE CAPITOL BUILDING AT SACRAMENTO, REPRODUCING A PRINT MADE FROM A PLATE BEFORE THE REDUCTION OF HIGH LIGHTS AND HALATION.

the arc lamps lighting it were shaded from the camera by means of pieces of card board attached to the lamps on the sides nearest the camera so as to obscure all the direct rays of light. These lamps were left burning throughout the entire exposure with the result that the thoroughfares and buildings, being well illuminated, are excellently reproduced. As stated, the exposure started at 9 P. M., and at 9:05 all arc lamps around the Court were turned off. The "blinkers," as the changeable lights in the tower were termed, were run until 9:30, but the buildings and incandescents, together with the search light and Firth wheel, which were kept stationary, were allowed to run until 10 o'clock, when the camera was capped. The electric fountain was played nightly for twenty minutes from 10 o'clock, and on this particular evening it had been arranged that at the close of its play all jets of the fountain would be operated under white light for five minutes additional, during which the camera was uncapped. It may be noted that the plate from which this photograph was taken was not treated in any way except by the application of red prussiate of potash, and that the night was windy and generally disagreeable.

An excellent specimen of night photography was secured recently at Glen Una, the home and prune ranch of Mr. Frank Hume near Los Gatos, Cal., and which is shown in Figure 9. The subject is situated in the midst of a grove of scrub oaks, which being very thick, and it being 10 o'clock at night, rendered the subject very dark. The exposure was commenced at 10 P. M., and stopped at 10:30, the only light being that of a single 2000 candle power arc lamp, and that of incandescent lamps concealed in the Japanese lanterns shown. No people appeared during this exposure, but instead, at its conclusion the people were grouped as shown, and an additional exposure of five minutes was made.

The photograph reproduced in Figure 10 shows the interior of the electric fountain, the striking feature of which is the manner in which the rays of light from the horizontal reflectors were brought out. This was the result of an accident. Several unsuccessful attempts had been made upon this subject, and it was finally concluded to make a time exposure of five minutes, upon the expiration of which time a flash light would be used, but when the cap was removed the flash light was accidently set off, filling the room with smoke which brought out the rays so much stronger that the exposure was continued ten minutes longer in order that the full effect might be secured. The plate was not treated in any way, and the lesson thus learned has since been of service many times in bringing out lighting effects that would otherwise have been impossible.

Considering the remarkable results that were attained in the way of night photography at the Midwinter Fair, regret will always be felt, perhaps by millions, that similar efforts were not undertaken during the late World's Fair at Chicago, and it is to be hoped that the officials of the Atlanta Exposition now in progress will embrace

FIGURE 7—THE ILLUMINATION OF THE STATE CAPITOL BUILDING AT SACRAMENTO, REPRODUCING A PRINT MADE FROM A PLATE AFTER THE REDUCTION OF HIGH LIGHTS AND HALATION.

the opportunity presented for further research in the realms of night photography.

"AS OTHERS SEE US."

The Electrical Journal changes its name with the September number, the third issue, to The Journal of Electricity. It is one of the best technical papers coming to the reviewer's table, and contains much valuable knowledge for the student as well as the practical electrician. The different departments are well edited, and The Journal under the management of Mr. George P. Low has from the start secured an enviable advertising patronage. The Overland Monthly, San Francisco.

THE MAGNETIC SEPARATION OF FREE GOLD. A SUGGESTION.

By Lieut. W. Stuart-Smith, U. S. N.

The writer was recently consulted regarding the possibility of utilizing electricity for the separation of the free gold from black sand, and, after some thought, conceived the idea of a magnetic separator, similar in principle to those in use for concentrating iron ores. Evidently a direct current cannot be used, since the metal to be separated is not capable of being influenced by constant magnetism.

The gold exists in a free state, consisting of very thin flakes, each of which may be considered as constituting a closed circuit. If, then, the magnets be energized by an alternating current of high frequency, and the sand containing the gold be passed in front of the poles in a thin stream, or be blown against the poles by a gentle air blast, the rapidly changing magnetism will generate in the contained metal currents of considerable magnitude, and the reaction between these and the magnetic field will cause the gold to be separated from the sand.

A small generator only would be required, and if only the larger and heavier particles of gold could be separated, it would seem that the sand could be worked at considerable profit, as the labor expended on the sand itself would be simply that required to shovel it into a hopper.

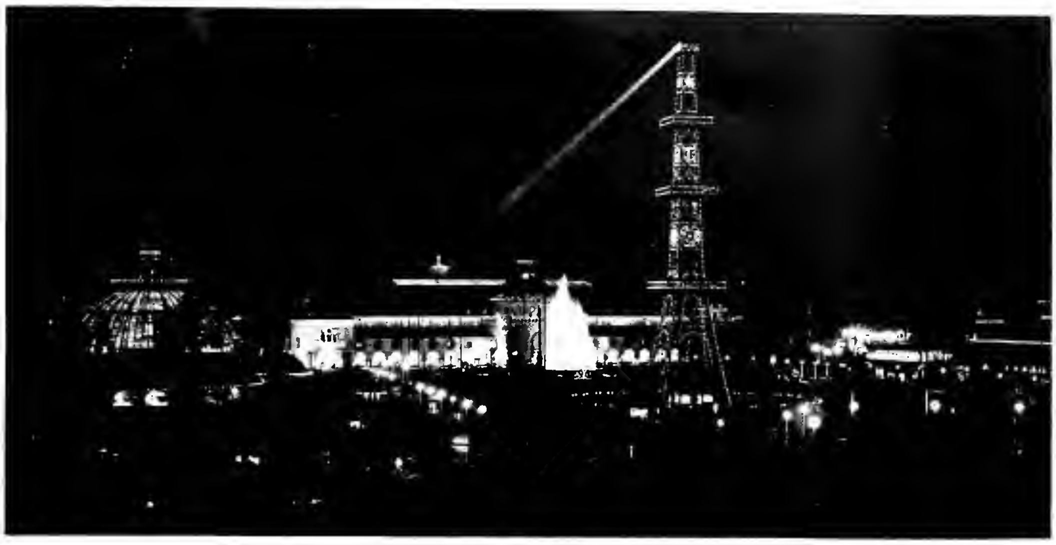


Figure 8—Night Photography. The Tower, Court and Liberal Arts Building of the Midwinter Fair. (Copyright 1894, by I. W. Taber.)

Figure 9—Night Photography. In the Grove at Glen Una, Time, 10 p. m.

Figure 10—Night Photography. Under the Electric Fountain at the Midwinter Fair.—A suggestion for bringing out light rays. (Copyright 1894, by I. W. Taber.)

AS OTHERS SEE US.

The Journal of Electricity (September)—The right to priority of claim to the title of The Electrical Journal which was raised by the papers of that name published respectively here and in Chicago, has been settled. Both papers came out at the same time and each claimed the name. The Journal here has at last decided to stop the controversy, and appears under the name of The Journal of Electricity, a name as fitting and in keeping, moreover, with its purposes. It is edited by George P. Low and F. A. C. Perrine, two well-known men in electrical circles. The September number has a prosperous appearance.—Engineer and Contractor, San Francisco.

DISPENSING WITH MAGNETOS IN TELEPHONE EXCHANGES.

While marvelous advances have been made in developing telephone exchanges to a high standard of excellence, there yet remains details which, though forming indispensable adjuncts, have received but little if any attention, and which stand to-day where they were a decade since. Prominent among these details is the magneto, which, except in the invention of improved features such as gearing so arranged as to automatically cut the magneto circuit in or out, as the case may be upon turning the crank handle, is to all intents the same device as was in use long before the invention of the telephone. It is universally conceded that the magneto itself is not a satisfactory appliance in telephone exchanges, particularly those of large proportions, yet despite this it is used almost exclusively, the only improvement applied being that it is driven by some motive power such as an electric motor. Some exchanges in the large cities are to-day operating dozens of small telephone magnetos which are driven by counter shafting and belting and require much attention.

Figure 11—Night Photography. The Santa Cruz Water Carnival, Showing Halation Circles and Film Burnings. (Copyright 1894, by I. W. Taber.)

For several years the local telephone system connecting various departments of the Edison Light and Power Company of San Francisco, which is operated through a local exchange in the office of the company, was equipped with a single ordinary magneto driven by an electric motor, the latter in turn being operated from the Edison underground circuit. Except for the noise and requiring occasional attention, the service was withal satisfactory, but nevertheless it is believed that it could be improved upon, and accordingly the apparatus shown in the accompanying illustration was installed.

As is evident from the cut, an Edison slow-speed fan motor having a rated capacity of one-twelfth of a horsepower is used, and by placing two collector rings on the other end of the armature shaft from that on which the commutator is located, and by connecting each ring respectively to diametrical points of the armature winding, the motor becomes a motor-generator, transforming the direct current it receives into an alternating current available at the collector rings and of a rate of alternation depending upon the speed of the armature. The electro-motive force of the alternating current is at all times equal to the electro-motive force of the direct current applied to the motor and the rate of alternation is, of course, twice the speed of the armature.

In the present instance, there being no 110-volt motor available, a 25-volt motor was used, and the voltage of the regular incandescent service is cut down to 25 volts by the interposition of incandescent lamps in series with the motor. From the brushes bearing upon the collector rings, leads are taken through a small double pole jaw switch to the primary of the small transformer, clearly shown in the illustration. This primary consists of No. 24 cotton-covered magnet wire, and the secondary winding has three times the length of the same size of wire. The transformer, therefore, builds up the potential from 25 volts to 75 volts, and as the speed of the motor is 1550 revolutions per minute, the rate of alternation is 3100 per minute.

It is found in practice that the ringing of a single 500-ohm bell checks the speed of the motor by about 150 revolutions per minute, while the speed of the motor is checked by about 500 revolutions per minute by throwing a dead short circuit upon the secondary of the transformer. In no other way than by checking the speed of the armature is a load manifested, and obviously under most adverse conditions, *i. e.*, a short circuit, can the conditions imposed be sufficiently severe to cause burning out or other injury. The bells rung from this device are vibrated more strongly than from a magneto.

Under usual conditions a 110-volt motor of the form described or otherwise, as may be desirable, would be used, in which event the transformer would be so wound as to step down from 110 volts to approximately 75 volts, under which conditions the energy consumed running at no load, but exciting the transformer, would be approximately 85 watts, while under full load the consumption will be 150 watts.

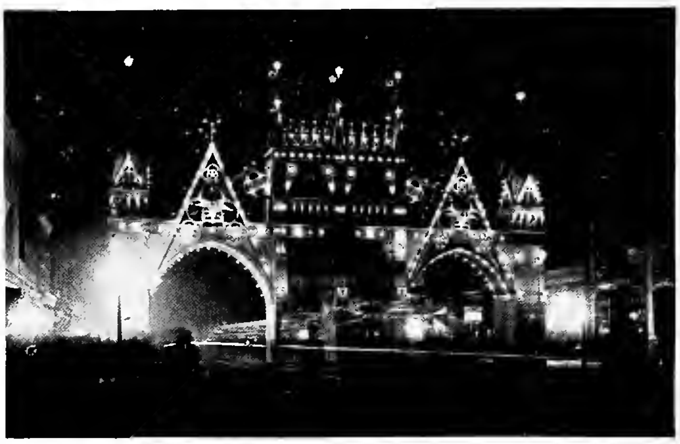


Figure 12—Night Photography. An Illuminated Arch Under Normal Exposure and Ordinary Development.

The entire outfit complete may be erected at slight cost, and will operate from ten to fifteen calls simultaneously with satisfaction. When equipped with self-oiling bearings and with carbon brushes the apparatus runs noiselessly and will not require attention oftener than once a month, if then. The arrangement is due to Mr. F. E. Smith, the chief electrician of the Edison Light and Power Company of San Francisco.

AS OTHERS SEE US.

We have at last received a copy of the first issue of our new contemporary, The Electrical Journal (San Francisco). The venture has received no little attention in the United States, and it is with interest that we turn over its pages. The articles are good.—Electricity, London.

Electro-Insurance.

THE INFLUENCE OF HEAT ON CARRYING CAPACITY.

A fire recently occurred in one of San Francisco's new office buildings, which, though quickly suppressed, caused damage to the amount of about $1000. At first sight it was said that the fire was caused by electric light wires, but after making a thorough examination it was reported that though the conduit tubing and wire insulation was burned away, yet the fire was due to causes other than the electric installation. Nevertheless, the examination disclosed a peculiarly vicious state of affairs in connection with the wiring, which it seems to the writer worth while calling attention to.

The iron columns supporting the floors are cased with closely-fitting tiling, considerable space being enclosed which is valuable as channel ways for wires, pipes, etc. In one of these wires were placed, enclosed in plain interior conduit tubing, and in the same space was placed a steam pipe carrying steam of 100 pounds per gauge. The space was closed, so as to be practically a dead air space, and the temperature must have been closely approximating to that of the steam. Steam of 100 pounds pressure has a temperature of 338° F., and therefore the wires must have had approximately this temperature when no current was passing.

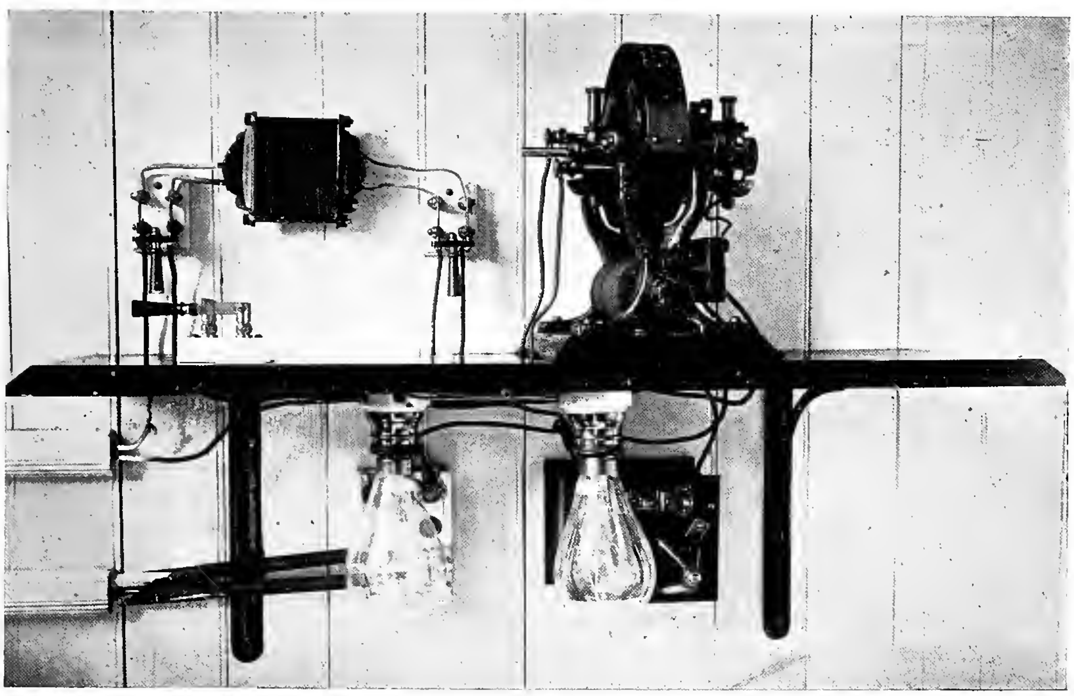
Wires are figured for a safe carrying capacity at 75° F., and for every degree above this the resistance increases .21% of 1. In this case the difference was 263°, or the total increase of resistance was 263 times .21% or 55%. It follows, therefore, that considering only the temperature due to the steam, the carrying capacity was reduced to 45% of the calculated amount, but this represents by no means the actual carrying capacity of the wire. The rules for safe carrying capacity are based upon the possibility of the heat generated being freely radiated, and in this case it is evident that this could not occur owing to the high temperature of the surrounding space. With the reduced conductivity the passage of the calculated safe current would cause a very considerable increase of temperature, which in itself would further lower the conductivity and cause a still further rise of temperature.

It will be seen, therefore, that while a calculation shows that the conductivity could not have been more than 45% of that for which estimate was made, it was in reality less than 45% by an amount that cannot even be guessed at. While it is reported that the electric installation was not the cause of the fire, yet it is readily conceivable that the wire might have been heated to redness. This case shows how thoroughly thoughtlessness may undo intention.

TO REVISE INSURANCE RULES.

The annual meeting of the Electrical Committee of the Underwriters' Electric Association is to be held in New York City during the week beginning December 9th, in view of which it has been deemed wise to adopt some plan by which all interested in the subject of rules for electric light and power wiring, whether members of this Association or not, can have an opportunity to make suggestions for the committee to consider.

It has seemed probable that some points, which might with advantage have been discussed, were lost because there were no written memoranda on the subject to bring the matter to the attention of the committee, and, as a result, forms have been printed for the use of those interested on which may be designated any features of the present requirements which may be deemed objectionable, or which it is believed could be amended, or on which suggestions regarding the formulation of new rules to cover points not now touched upon. These blanks may be obtained upon application to C. M. Goddard, Secretary, 55 Kilby street, Boston, or Geo. P. Low, member of the committee, 303 California street, San Francisco, and must be filled out and mailed to Mr. Goddard on or before December 1st.



DISPENSING WITH MAGNETOS IN TELEPHONE EXCHANGES.

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power

EDITED BY

F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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EDITORIAL.

AN IDEA FOR BICYCLE BUILDERS.

The importance of a satisfactory headlight for a bicycle is well recognized both by those who have attempted to use any one of the standard headlights, and by those who have been so unfortunate as to encounter a "scorcher" riding at night without a lantern. Most bicyclists prefer to ride entirely without a light for the reason that the lanterns on the market are not capable of giving a sufficient amount of illumination to materially aid the rider in picking his way, though there is no doubt that for pedestrians some visual notice of the coming of so noiseless a vehicle is important.

The photometric tests presented in another column show an extraordinary small amount of candle power of the standard oil lanterns in spite of the fact that the entire light from the flame is concentrated in one direction by means of lenses and reflectors. The burden of the additional weight of a battery for an electric light, which is far more satisfactory, is in general too great to receive unqualified endorsement at the hands of enthusiasts that are constantly striving to attain lighter weight in bicycles.

In casting around for a feasible method for an improved illuminant for bicycle lanterns, one is struck with the fact that for a given amount of weight and bulk there is nothing that will exceed acetylene gas. The tubes of a bicycle frame, which may be readily connected together, contain a volume of about sixty-five cubic inches, and are sufficiently strong to withstand an internal pressure of 2000 pounds per square inch, using a factor of safety of about seven. If an arrangement could be made for charging these tubes with a burning mixture of acetylene and carbon mon-oxide to a pressure not exceeding 600 pounds to the square inch, sufficient gas might be stored to furnish a burner giving about twelve candle power for a period of at least four hours. Burners containing reducing valves for burning the gas under these conditions are on the market, and in use in the Pintsch gas systems which illuminate the standard railway trains. The difficulty of charging is one which might readily be overcome by the establishment of hand pumps in bicycle repair shops, while the burden of weight and expense would not be very much greater than they are at present with coal oil illumination.

CONCERNING THE NEW SACRAMENTO.

Recent information which has just been furnished concerning the capitalization of the various electrical interests of the city of Sacramento has proven the error of surmises lately published in this paper to the effect that unless consolidation or other combination should occur, the city named is on the eve of a struggle of commercial supremacy between its two electric systems. "One side," it was pointed out, "is ranged on the vantage ground of abundant water power, but its forces are crippled because of the heavy interest charges that must be met; the opposing side is free from bonded indebtedness. Its interest charges are light, and by the substitution of gas engines for its present steam plant, and by effecting other changes, it can render service at exceedingly low rates."

The interests referred to are those of the Sacramento Electric Power and Light Company and the Capital Gas Company, respectively, and the publication has brought out new information, from which it appears that the bonded debt of the Capital Gas Company is $150,000 in twenty year 6 per cent. bonds, issued on November 1st, 1890, and that its capital stock is $500,000, in 10,000 shares of $50 each, representing an investment of $650,000. The proportion of this amount that is chargeable to the electric plant may be assumed to be about 50 per cent. approximately per 1000 horse-power. It also appears from statements furnished by the Sacramento Electric Power and Light Company that of the entire bonded issue of the latter company, amounting to $1,500,000, only $300,000 was expended for hydraulic works and exclusive water power privileges. The street railway system of Sacramento, which covers the entire city and which already earns a sum equal to the entire amount of the fixed charges of the Sacramento Electric Power and Light Company, cost $600,000.

Further figures rendered are of interest as showing that the expenditures on account of the present hydraulic and electric generating plant (of 4000 horse-power) together with the transmission line to Sacramento and the new electrical equipment of the sub-station, amounted to $375,000, in addition to which the sum of approximately $125,000 was expended in the construction of the Folsom power house and the Sacramento sub-station. These expenditures make an aggregate issue fo bonds amounting to $1,400,000, leaving a reserve of $100,000 in bonds in the Company's treasury.

Bearing in mind the fact that the revenues of the street railway system, which consumes but about one-fifth of the power output of the present plant, are alone sufficient to defray all fixed charges on the entire transmission and street railway plant, it is evident that the Sacramento Electric Power & Light Company is in a position not only to meet any competition that may arise,

but to furnish power at figures that will seem astonishingly low to Californians. Indeed, the era of cheap power for Sacramento may be said to have opened by the awarding of the contract to the Sacramento Electric Power and Light Company for lighting the streets of the city at a rate one-third lower than had been paid before, but which rate is nevertheless highly profitable to the Company because of its ability to deliver electric power at exceedingly low cost.

ELECTRIC TRACTION FOR COUNTRY ROADS.

The fact that the excellence of the country roads throughout the English agricultural districts has not prevented the farmers from demanding a cheaper method of transportation for the produce than can be obtained by the ordinary means of haulage by teams, indicates that the movement for good roads, which is so universal throughout this country, demands most careful consideration and investigation. The claim is made by those advocating an improvement in the character of the highways that this improvement is demanded by agricultural communities. In England, as has been stated, these communities are at the present time asking for light railways to take the place of team haulage. In this country the movement for good roads has been successful mainly in suburban districts, where their introduction has changed the land from property valuable as agricultural investments to property even more valuable for suburban residences, and when the work which has been actually done in making good roads is examined carefully, it is found that the cases in which progress has been made are very rarely in the midst of an agricultural community. In our last issue we noticed the success attendant upon undertaking the introduction of freight cars on the Oakland and Haywards (Cal.) electric line, and the fact is that these freight cars are being patronized by trucking teamsters, who find it cheaper to load their wagons upon the cars rather than to haul them to the city by teams.

In the State of Ohio a Legislative Commission has reported that the expense of putting the highways in the condition demanded by the advocates of good roads would be nearly if not quite equal to the expense incident to the laying of tram tracks along all of these highways and equipping the greater portion of them with electric power. In a thickly settled suburban district there is no doubt but that the availability of the highways for pleasure driving and bicycling is more important than their adaptability for heavy teaming, but, in localities where the question of haulage is the more important one, we should be very slow in assuming that a greater economy to the community can be obtained by the improvement of the highways as a whole than by any means which would facilitate heavy haulage irrespective of the adaptability to light driving. A roadway 30 or 40 feet wide is unnecessary for the purposes of heavy haulage, all that is required being a solid tread for the wheels of the trucks used, and, if no other motive power is provided, a solid way for the horses.

Such a road as this was constructed long ago over the swampy ground lying between the cities of Albany and Schenectady, in the State of New York, the tread for the wheels being long granite blocks, about fourteen inches wide, between which cobbles were laid for bearing the weight of the horses. Thousands of tons of merchandise have been carried over this road during the past twenty-five years, and a better road or easier haulage would be difficult to find when the purposes for which it was designed are taken into account. Throughout the State of California there are immense quantities of timber, building stone and ore which cannot be worked for a greater portion of the year on account of the impassable condition of the highways, and to bring the roads to such a condition that teaming would be possible throughout all seasons of the year would, in general, cost more to the community than could possibly be afforded. At the same time it would be wrong to say that no endeavor should be made to make these sources of wealth more commonly available. In many such regions the laying of a simple tramway with a tread adapted to wagon wheels would solve the problem, while in some regions, where water power is available, it might be economical to equip the roads with electric power, and should this be done it would not be necessary to utilize any other rolling stock than the ordinary country wagon. We are not aware that this plan has been tried on any established tramway, though the analogous scheme of hauling country wagons by the means of a road engine has been found economical, both throughout the confines of our own State and in many other localities adapted to the use of the steam-road engine.

Advocating this plan may be looking very far into the future, but it certainly seems that, with the general advance in engineering knowledge, we may hope that, in considering the question of the improvement of highways, more of our County Commissioners may consider the economy to be obtained in haulage of produce by laying iron tramways which will be ultimately adaptable to the purposes of electric haulage.

POWER TRANSMISSION BY COMPRESSED AIR.

The importance of compressed air as a means of transmitting power is more readily appreciated on the Pacific Coast, where successful mine plants have been for so many years using air compressors, than in sections of the country where this work is entirely unfamiliar.

Although the transmission of power by the means of water at a pressure of 750 pounds per square inch has been financially successful in London, and the steam distributing plant in New York has undoubtedly paid ample dividends, yet the difficulties encountered by the two companies using these systems have been so great that it is doubtful whether there will be in future any considerable amount of power distributed in this manner from plants yet to be constructed.

The transmission of power by means of natural gas through long pipe lines has been so completely successful in this country, and the great economy of the Popp compressed air system in Paris, indicate that these means of transmission may become competitors of electrical transmission systems over very considerable dis-

tances. The transmission of fuel gas at a high pressure is not of particular importance where the coal mines are distant, except in so far as the construction and maintenance of the pipe line bears upon the question of the transmission of compressed air. The fact that the combined efficiency of an air compressor and motor may reach as high a value as 80 per cent. shows that the high efficiencies realized with dynamos and motors may be equalled and perhaps exceeded with compressed air apparatus.

The great advantages incident to a compressed air transmission are to be seen when we consider that the power is readily subdivided into small units, and that an ordinary steam engine, with but few modifications, is capable of acting efficiently as an air motor; that the danger of life and property is a minimum when it is compared to any other system of transmission, and that no return mains are necessary, either for obtaining the greatest economy, or for the disposition of disagreeable products. As regards the efficiency of transmission, compressed air is at a disadvantage only when compared with electricity at a high tension transmitted by overhead lines, although recent statements are made by pneumatic engineers which may lead to the economical use of air at high pressure.

With air at 115 pounds initial absolute pressure, and an initial velocity of 25 feet per second, the terminal pressure at the end of ten miles will be equal to 85.7 pounds and the terminal velocity equal to 33.6 feet per second, when a twelve-inch main is used. If the initial velocity is increased to 50 feet per second, then at the end of six miles the pressure will have been reduced to that of the atmosphere. It is therefore seen that pipes of a large diameter must be laid for the transmission of compressed air at low pressures over a considerable distance, and that although the total amount of power transmitted will be increased, it has not yet been definitely determined whether any advance in efficiency is obtained by increasing the initial pressures. The new mains laid by the Paris Compressed Air System, 7 kilometers in length and 20 inches in diameter, using air at 90 pounds per square inch, are capable of transmitting 6000 horsepower. With a main of this size, the necessary construction for guarding against excessive leakages is of course very expensive, and in some instances it has been found necessary to lay double mains, one enclosing the other, in the natural gas region, where pressures from 250 to 500 pounds per square inch have been encountered. The demand for high-pressure air-pipes will no doubt produce something much better and cheaper than is now to be obtained, and the immediate future will determine whether high-pressure air is to be a successful rival of high-tension electrical currents. For shorter distances and lower pressures we have the results of the Paris Company to assure us that a loss of pressure exceeding 8 per cent. is unnecessary in a city net-work containing thirty-four miles of pipe. This economy, we think, compares favorably with the results obtained in the transmission of electricity over small distances, and indicates that in cases where large water powers are available near manufacturing centers, the question of the total initial cost of plant and economy of management demands very careful consideration before it is possible to say that an electrical transmission is the more certain to be successful.

Electrical transmission has the undoubted advantage of having been more completely exploited and the sources of economy more completely understood, but with the introduction of more efficient air compressors and motors we are beginning to see the possibility of a serious competitor in compressed air for delivering power to many consumers throughout a manufacturing center.

NATIONAL SCHOOL OF ELECTRICITY.

Of late several classes of the National School of Electricity have been organized in several cities of the Pacific Coast under a plan of instruction similar to the Chatauqua courses in literary circles. The lesson leaves of the National School were prepared by Prof. Dugald C. Jackson, of the University of Wisconsin, which at once places their accuracy and reliability above question. The mode of procedure is simple. Upon the organization of a class in any locality an instructor is selected who uses the leaflets as a text, illustrating each lesson by means of experimental apparatus furnished by the school. Each course embodies some thirty odd lessons, at the conclusion of which the student should have acquired at least elementary information concerning the fundamental principles and the general applications of electrical science. The student will have learned, for instance, how to technically distinguish between an electrical possibility and an electrical impossibility—a perception, which, if possessed by all business men, would prevent investment in the many fraudulent schemes that are daily foisted upon the credulous public. The National School does not profess to turn out finished electrical engineers, and those aspiring to thoroughness in that profession must look to such well-established seats of learning as the University of California or Stanford University for their education. Its course is one eminently adapted to the needs of the business man who desires general information concerning electrical matters, but who has neither the time nor the inclination to make himself profound in the subject.

The National School of Electricity has been the recipient of no little comment, favorable or otherwise, at the hands of the electrical press. We know that the names on its honorary faculty insure accuracy and thoroughness in the technical preparation of its lesson leaves throughout the scope they are designed to include. The School has struck a popular chord, for it now has enrolled throughout the country upwards of 4000 students, while, in the west, hundreds stand ready to enlist when they are convinced that the administration of the scheme shall prove as unimpeachable as are the names of its honorary faculty. With the organization of the San Francisco class of the National School is presented an opportunity for determining the real efficacy of a scheme that the eastern electrical press and reports have harped discordantly upon, and the conclusions thus reached will here be recorded.

Passing Comment.

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

The Electrical Engineer has devoted prominent space to an article by Mr. George D. Burton on smelting refractory ores in an electric furnace, in which he reports results that may be important to California miners; in fact a number of the experiments seem to have taken place in this State, though the results which are stated most concretely refer to the smelting of copper ores in Canada. "Electricity" has charged that the statements in this article are manifestly inaccurate, though it does not venture to give any figures to show where the inaccuracies lie. Perhaps exception might be taken to the statement made by Mr. Burton that the smelting charges for gold and silver ores amount to as much as seventeen dollars per ton, though he is very careful to state that this is true only in some cases. A smelter charging so high a price would hardly do a very extensive business amongst California miners. On the other hand, in giving a concrete example of what can be done with his electrical furnace, Mr. Burton states that he has smelted a ton of Canadian nickel ore with an expenditure of 2000 amperes at 250 volts in forty minutes, producing a mat containing 27½ per cent. of pure nickel. The energy delivered in the time stated by Mr. Burton amounts to the delivery to the ore of about a million and a quarter of heat units. While taking the statement made by the best Government assayers that Canadian nickel ore contains about 3 per cent of nickel and a similar amount of copper in "gangue" (composed mainly of iron pyrites) and referring to the table of specific heats given by F. W. Clarke in his Smithsonian publication, we find that more than three million heat units will be required to raise the mass of a ton of ore to the temperature of smelting. This presents a discrepancy in figures, which Mr. Burton will find hard to reconcile.

Judging from the articles seen in several recent papers, it appears that the manufacturers of incandescent lamps are greatly concerned over the question of a satisfactory universal lamp base to facilitate the handling of stocks in these days of low prices. One will readily appreciate the difficulty when it is stated that an incandescent lamp manufacturer must carry stocks of fifteen or twenty different voltages, and that these lamps may be ordered at any time to fit in one of half a dozen different kinds of lamp sockets. The cost of the caps for the different sockets vary from one-half cent to five cents, yet lamp users can rarely see why they should pay more for a Schaefer or Thomson-Houston base than they would for an Edison or a Westinghouse. Undoubtedly the elimination of many odd bases, and the reduction to one or two forms would facilitate carrying stocks, and greatly decrease the cost of manufacture, but on the other hand, the user sometimes has good reason for his choice of a definite socket or of more than one socket in the same building. Plants which are run from storage batteries, and plants in which the regulation of light is affected by a change of voltage in different parts of the system, as well as occasional plants using both direct and alternating system of different voltages need an easy method of separating their stocks of lamps, and there is no surer guard against error on the part of ignorant workmen than can be found by using different sockets for different kinds of lamps. There is also the need in hotels and public buildings that the exchange of lamps from one socket to another be kept entirely in the hands of workmen appointed to make such changes, and as no method for locking a lamp in its socket has been devised, such plants must be equipped with more than a single style of base. If there is so urgent a need for the solution of this question, it may be found rather in the method employed by German lamp manufacturers than in the attempt to have a standard base adopted. The lamp makers in Germany, who are undoubtedly producing and selling lamps at a lower price than those elsewhere, have for some time adopted the plan of putting the lamps on the market entirely without bases, and allowing selling agents and central stations to do their own capping, and, where capping is done by the manufacturer, to make a charge covering the cost of the particular cap applied to the lamp. Under such circumstances, lamps can be had at a definite cost for the lamp itself, and all users of the lamps adopt the particular socket which will allow the cheapest lamp base adaptable to their needs.

In the Electrical World for September 14th appeared an article by Keppele Hall appealing for better construction work on the part of contractors doing interior wiring, in which the sweeping assertion is made that this work is done on an average by men incompetent on account of deficiency in training, and who are both unable and unwilling to do so much as a neat job in carpentering. No doubt, in many small towns where electricity has only recently been introduced into dwellings, there is much justice in this statement, but we hardly think that it is true on an average that men doing electrical wiring are of the character described. No better proof of the improvement in efficiency made by electrical contractors can be found, than on the one hand, the gradual disappearance of the poorest grades of insulation on the market, and the steady growth of manufacturing companies who have uniformly preserved a high standard for their wares. On the other hand, we have the results published by the insurance inspectors to prove that, in spite of the great increase in the use of electricity during the past years, the proportion of fires due to defective workmanship in electrical installations has very greatly decreased. It is unfortunate that it has become the custom on the part of men of short experience, who have established themselves in districts where a greater or less amount of slipshod work is going on, to jump at once to the conclusion that their experience is the common one throughout the country. On the contrary, the average character of the electrical contractors is steadily rising, and architects are recognizing the necessity for the aid of efficient electrical engineers in laying out and subdividing the wiring systems, until throughout the manufacturing centers of New England, as well as in most large cities, but little work is undertaken without the personal supervision of some engineer. It appears that at no time in the history of electric lighting has there been less call for such a plea than at the present, and there is no doubt but that if the present demand for efficient superintendence in electrical undertakings is continued, the slipshod contractor will disappear on account of the unfavorable character of his business.

The Electrical Review of September 25th prints an interesting article on Hornsby-Akroyd Petroleum Engine, which may take an important position in the field for cheap prime movers, and which contains elements that might profitably be studied by the local manufacturers of gasoline engines. It has been the practice of gasoline engine manufacturers to rely almost entirely upon an electric spark for igniting their gases, and every user of these engines knows the difficulties that are encountered in keeping the batteries, spark coils and conductors in working order. English engineers have largely abandoned the spark coil for a porcelain tube ex-

tending into the explosion chamber, and maintained at a red heat by means of a small Bunsen burner playing upon the inside of the tube. By this means, the ignition of the mixture is effected whenever the mixture of gases attains the proper constitution and density, and, as a result, more constant service has been attained. From the standpoint of the manufacturer, the certainty of ignition may seem less important than a complexity of governing gear, and we venture to assert that should our manufacturers overcome this great trouble to the users of such engines, there would be small objection raised to the added parts necessary for effecting governing by the variation of the amount of injected gas.

Literature.

FACTS and HIGH PRESSURE. Pamphlets for gratuitous circulation, BABCOCK AND WILLCOX COMPANY, New York, 1895, by Chas. C. Moore & Co., Pacific Coast Managers, 32 First street, San Francisco.

We have lately received from the Babcock and Willcox Company two pamphlets concerning the manufacture of water tube boilers. These pamphlets are additions to their very valuable book on "Steam," which is familiar to all engineers. In the pamphlet entitled "Facts" is contained descriptions of the various water tube boilers designed in this and other countries from the early attempts of Stevens in 1805 down to the more modern boilers exhibited at the Chicago Fair. All of the designs are here described under four distinct heads: First, boilers containing tubes with closed ends; secondly, boilers composed of bent pipes; thirdly, boilers composed of pipes and fittings; and fourthly, boilers composed of pipes closed at both ends. In each case the boilers are described with the implication that they have been abandoned on account of the impossibility of cleaning the tubes, but it seems to be too much of an assumption for any manufacturer to claim that such boilers as the Thorneycroft, Morrin or Sterling have been entirely abandoned, or to imply that the Henshall boiler is no longer manufactured. There is no doubt but that this pamphlet contains a great number of important forms, and, directly considered, will guard the purchaser against abandoned experiments, though it is unfortunate that no tests are given with any of these important designs.

In the pamphlet on "High Pressure" we are pleased to see so complete a description of the methods of manufacture and materials used in producing the Babcock and Willcox boilers for high pressure steam. Recent advances in steam engine manufacture have created a demand for boilers capable of delivering steam at pressures even as high as 200 pounds per square inch. Where such high pressures are used it is necessary that we be assured of perfection in every part of the manufacture of the boiler, and it is no small consideration to the engineer for him to be able to see so well an established firm as the Babcock and Willcox Company are, manufacturing their admirable type of boiler in a manner calculated to give as nearly perfect results as can be obtained.

ELECTRICAL MEASUREMENTS: A Laboratory Manual; H. S. CARHART, M. A., L. L. D., and G. W. PATTERSON, JR., M. A., B. S. Allyn & Bacon, Boston, pp. 350.

It is with considerable satisfaction that we take up the Laboratory Manual of Professors Carhart and Patterson, and notice that the modern methods of measurement heretofore accessible only in "Gray's Treatise on Absolute Measurements" have been reduced to such clearness that they become intelligible to students, and susceptible of being applied by the average engineer. The special apparatus of the particular laboratory from which the book is issued has not dominated the character of this treatise or burdened it with the defects of other laboratory manuals which have been heretofore issued. The fact that these authors have treated the subject of electrical measurements from the stand-point of the physicist rather than that of the electrical engineer, has divested their work of a considerable amount of complication and unnecessary detail, while at the same time an extension of their methods of measurement to practical application lies within the power of an engineer using the book, on account ef the distinctness with which the various quantative measurements are explained. Being written from the standpoint of physical electrical measurements, the subjects treated are limited to the measurements of resistance, current, electro-motive forces, quantity and capacity, induction, magnetization and hysteresis. The discussion of units, which forms the introduction to the work, are entirely in accordance with the scientific c. g. s. system, and treat the results of the Paris and Chicago conventions most completely. The entire elimination of all other systems from this chapter unfortunately fails to clear up the mind before the average student the complete subject of dimentional formula. Even the physicist must occasionally refer to the papers of engineers where complicated unit systems are in use, and it seems that the authors would not have degraded the quality of their work had they introduced examples showing the methods of conversion from the British unit systems into the scientific c. g. s. system.

Where apparatus has been described as in the case of resistance boxes, galvanometers and scales, balances, standard cells and standards of capacity, the treatment is particularly rational and specific; though the necessity for absolute cleanliness and high insulation of all keys and wires is given more by implication than direct instruction, which is perhaps all that is necessary in a well-arranged laboratory, where tables are dry and free from fog and dust, but which must be insisted upon both to the practical engineer and to the student working under less than ideal conditions. In the same vein we would desire more specific instruction concerning the adjustment of a differential galvanometer throughout its range of reading, rather than simply at the zero point. The treatment of the Wheatstone bridge and its errors is noticeably complete, but the difficulty in locating the minimum point of deflection of the galvanometer, which most students experience, might well be borne in mind, and the production of an appreciable swing by timing the contact and periodicity of the galvanometer as used by Faraday and Henry should not be considered beneath the notice of the modern experimenter. The example given of the change of resistance of a dielectric with electrification shows this action, although in the text of the experiment we fail to find any mention of its existence or signification.

It is fortunate that so clear a description of the silver and copper voltameter has been at last made accessible to those not having Raleigh's papers or Gray's Manual at their hand, and the familiarization of this piece of apparatus will tend much to the accurate calibration of commercial apparatus. While the treatment of self and mutual induction is undoubtedly as complete as can be found in any other book, it seems unfortunate that the difficulties attendant upon the measurement of distributed capacities and self induction are not indicated with sufficient clearness to avoid the confusion of their measurement with the measurements of localised capacity and self induction. When we come to the subject of magnetism and hysteresis we find the best recognized methods carefully explained, though the errors of Hopkinson's bar and yoke and Bidwell's divided ring methods in the hands of an ordinary experi-

menter seem to be too lightly called to attention. The fact that the machine work, to give accurate results with these methods and to eliminate the influence of the gap at the division of the bar or ring, is one that is unlikely to occur to the average observer who may rely upon these methods. It is to be regretted that these authors have not treated the subject of the absolute measurement of résistance, since the apparatus of Lorentz has become almost a necessary adjunct to any laboratory where low resistance of great carrying capacity is adjusted. The criticisms that have been made of this book are not at all intended to indicate that the work is materially lacking in either scope or method of treatment, but, on the contrary, we have nothing that has heretofore given us so carefully and well the best recognized method of physical electrical measurements.

CRUDE PETROLEUM FOR FUEL.

By Geo. H. Larkin.

Believing that consumers of steam power will be interested in the result of some tests recently made by the writer in the use of crude petroleum for fuel, I have prepared the following. The tests were made under horizontal return flue tubular boilers at the works of the Pacific Rolling Mills, San Francisco, using the Union Oil Company's standard 23 degree gravity fuel oil from the Santa Paula (Cal.) oil fields, fed through the Larkin oil burner.

The oil was pumped from a car tank into an old ship tank holding about 90 barrels, which was placed on a platform slightly raised from the ground about 60 feet from the boilers, on which were placed two drums, 28.4 inches in diameter and about 40 inches high. These two drums were connected to the ship tank and also to the oil pump used for feeding the burners, and were filled and emptied alternately, 30 inches of oil being used out of drum No. 1, which was then disconnected and filled, when drum No. 2 was connected and 30 inches used out of it after the same manner. The water consumed was handled in the same way, two water tanks being used that were filled from the Spring Valley Water Company's system, and 60 inches of water being taken from tanks Nos. 1 and 2 alternately. The oil weighed 19 pounds to each inch in depth of the drum, and the water weighed 257 pounds to the inch in depth of tank. While the weight of the water is, of course, constant, the weight of the oil varies, but as all fuel oil is sold by a standard measured unit of 42 gallons to a barrel, the same number of pounds per inch in drum was allowed, as in previous tests made with other oils, which was considered the simplest and most satisfactory way of determining the comparative value of different oils.

These boilers have been used for all of the previous fuel tests made at the Rolling Mills, and were in good condition, being clean and of good draught, but they were not enclosed in the building. All water connections for both feed and blow-off were disconnected, and blind gaskets were put in where necessary. The boilers were fed by an injector to the disconnected end of the boiler feed pipe, and the steam pipe leading from the boiler was connected to the main steam line of the Rolling Mills, and regular fires were kept up during the entire time of tests Nos. 1 and 2.

For test No. 3, the boilers were separated from the main line and were used to run the 6 and 8-inch mills alternately. This necessitated frequent stoppage of the fire, as at short intervals the mills were shut down and the consumption of steam was only about one-half of the rating of the two boilers. The amounts of water and oil used were carefully measured by men appointed by Mr. P. Noble, Superintendent of the Rolling Mills, and their work was continued during the two or more weeks of the test.

The results obtained from the three tests made are shown in the accompanying table.

Test No. 1 designates the first week's run, from which it will be observed that the boilers were forced considerably above their normal rating, and that consequently the terminal temperature was too high for good economy. The apparent high evaporative efficiency under the conditions given is due to the fact that the oil used was about 9% heavier than was allowed by the measurements per inch in the oil drum, as before explained.

In test No. 2 the stack temperature was reduced to a more theoretical point, and the boilers were run to about their nominal rating, and, as a result, test No. 2 shows considerably better efficiency than test No. 1. The increased evaporation is the direct result of a reduced terminal temperature, and the high efficiency attained is due to the fact that the furnace temperature was very high, while the terminal temperature was almost theoretical. That these boilers furnish practically dry steam to the main line is an assured fact, and while no calorimeter was used, there was no lack of opportunity to observe the appearance of the steam at the openings left at the connections of the steam pipe to the steam drum on the boilers, and at these points the steam showed bluish in color and nearly transparent at some distance from the orifice.

While the results of test No. 3 are absolutely correct, they are apt to be misleading, unless more fully explained. The boilers were disconnected from the main line, as stated, and were connected to the 8-inch mill without any stoppage, and as they had been running for 112 hours continuously, at their normal rating, the heat stored up in the brick work became active upon the fires being reduced, and the boilers ran at about one-half the rated capacity. This explains the high showing made by oil in this separated test, the duration of which was only $8\frac{1}{2}$ hours. The percentage of gain would of course be less the longer the test was continued.

In tests Nos. 1 and 2 the fires were started under cold boilers, and the amount of oil used in getting up steam is included in the table. At the conclusion of the tests, the oil and feed water were shut off at almost the same time, the water in the gauge glasses being brought up to the same level as when starting up. This left the boilers full of hot water, and the brick work hot, for which the oil received no credit. This difference is plainly shown by comparing a continuous run with the 24-hour run, in which the test started and stopped with hot boilers. For instance, the oil and water report for August 30th, shows that the oil used from 11:27 P. M. on the 29th, to 11:09 P. M. on the 30th, was 360 inches, or 6840 pounds, the time being 23 hours and 28 minutes, and water used from 9:10 P. M. on the 29th, to 9:35 P. M. on the 30th, was 420 inches, or 107,940 pounds, the time being 24 hours and 25 minutes. As the difference in time was 57 minutes between the beginning and ending measurements for the water and oil respectively, a deduction of about 15 inches, or 3855 pounds of water, should be made, which makes the water and oil consumption on August 30th to be as follows:

Oil consumed	6,840 lbs.
Water evaporated	104,085 lbs.
Water evaporated, per pound of oil under actual conditions.........	15.21 lbs.
Water evaporated per pound of oil from and at 212 F...	18.31 lbs.

A deduction of 9% from these results should be made for the difference between the drum measurement and

the actual weight of the oil, which brings the actual evaporation from and at 212° F. per pound of oil to 16.67 pounds for a continuous run of 23 hours and 28 minutes.

CRUDE PETROLEUM FOR FUEL.

Oil used, California crude, from Santa Paula, Cal.
Kind of boilers, horizontal return tubular.

	Test No. 1.	Test No. 2.	Test No. 3.
Size of boilers...........	54″x16′	54″x16′	54″x16′
Number and size of flues..	54 4″	54 4″	54 4″
Rated horse power.......	75	75	75
Steam pressure	75	75	75
Temperature of feed water	60° F.	60 F.	60 F.
Stack temperature (av'g).	600 F.	480 F.	400 F.
Total oil consumption....	46,217 ℔s.	31,198 ℔s.	1,463 ℔s.
Total water evaporation..	707,778 ℔s.	460,030 ℔s.	23,130 ℔s.
Pounds of water (60) evaporated ℘ ℔ of oil..	14.09 ℔s.	14.74 ℔s.	15.80 ℔s.
Pounds of water (212°) evaporated ℘ ℔ of oil..	16.79 ℔s.	17.55 ℔s.	18.83 ℔s.
Total HP developed......	27,231.5	17,634	886
HP per hour..............	260	157	104
HP per boiler............	130	78.5	52
Oil used per HP hour.....	1.8 ℔s.	1.7 ℔s.	1.6 ℔s.
Duration of test.........	104 h. 35 m.	112 h. 9 m.	8 h. 30 m.

SOME TESTS OF BICYCLE LANTERNS.

By F. E. Smith.

Believing that publications of the tests of the various means in use for lighting bicycles at the present time will be of popular if not technical interest, the writer gives below the results of measurements originally made as a matter of personal satisfaction. Before presenting the same it is well, however, to point out the distinction that should be drawn between a riding light and the signal light. The lanterns ordinarily used can, after a consideration of these experiments, be considered only as signal lights, or those containing visual warning of approach. As a means of illuminating the roadway they can be considered only as a partial or doubtful success. With a riding light, however, the roadway becomes sufficiently illuminated for thirty or forty feet, or even a greater distance ahead, so that travel can be accomplished with ease and safety. In the present state of bicycling by night, signal lights without number are available, but riding lights, though eagerly sought, are not to be obtained. Original experiment in this direction led to the construction of an electric lantern, consisting of three cells of storage battery operating a small one candle-power incandescent lamp arranged in a suitable reflector placed upon a bicycle, as shown in the accompanying illustration. This is the apparatus referred to below.

The two forms of oil lanterns which are believed to be the best were selected for the test. These burned signal oil and kerosene oil, respectively, and their weights, when filled, were 20 and 40 ounces, respectively. They were tested under the best possible conditions as to trimming, polish, etc.

The electric lantern is operated, as stated, from three cells of storage battery of the Hough type, each cell containing two plates 1½ inches by 3¾ inches in size. The lamp used was manufactured by Geo E. Lamont, a San Francisco manufacturer, and is rated at one candle-power, is of 4 watts efficiency, and consuming .7 of an ampere at 6 volts. The battery will operate this lamp about four hours continuously. The weight of the battery and lamp complete is 36 ounces.

All candle-power measurements were made by means of the standard Lummer-Brodhen photometer in the laboratory of the Edison Light and Power Company of San Francisco, the photometer having a distance of 100 inches between centers. For a standard, a 16 candle-power incandescent lamp, previously standardized from standard English sperm candles burning 120 grains per

Some Tests of Bicycle Lanterns.

per hour, was used, and under these conditions, which are accurate, the various lanterns gave the following tests:

Oil lantern No. 1, burning signal oil.......... 3¼ candle power.
Oil lantern No. 2, burning kerosene.......... 6½ " "
Electric lantern, consuming 4.2 watts........45 " "

I may add, as an illustration of the efficiency of the electric lantern, that during the recent eclipse of the moon, when no street lamps were lighted and the streets of San Francisco were in intense darkness, I was able, with the aid of the electric lantern on my bicycle, to discern another bicyclist turn into the street at the further end of the block, a distance of 600 feet away. The electric lantern gives a splendid riding light and illuminates the roadway brilliantly for a distance of 50 feet. In addition to the headlight, there can be used a rear electric lantern, operated from the same battery, to be used as a signal light. In my machine this consists of a red light attached to the saddle post and pointing backward.

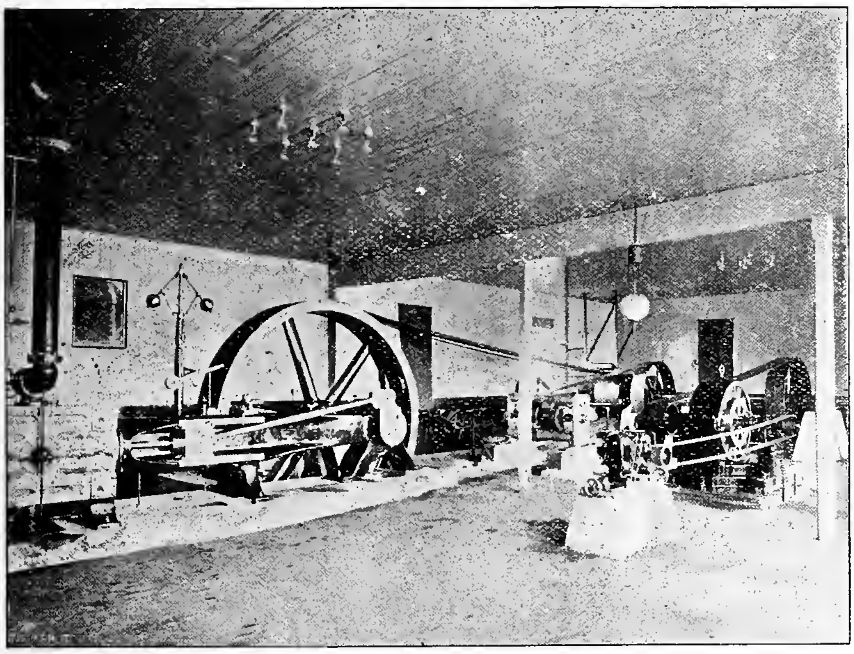
Mr. G. P. Low has decided to call his excellent electrical paper, published in San Francisco, The Journal of Electricity, under which name he will continue to demonstrate the high stage that electrical engineering and education has reached on the Pacific slope.—Electrical Engineer, New York.

We have at last received a copy of the first issue of our new contemporary. The venture has received no little attention in the United States, and it is with interest that we turn over its pages * * * The articles are good.—Electricity, London.

A COMMERCIAL SUCCESS FROM A MUNICIPAL FAILURE.

A noteworthy instance in which municipal authorities have taken up the question of city lighting and have installed a plant to meet the conditions which they believe to have existed, and after extensive trial have failed to score a success, while the same plant after having passed into the control of private parties has rapidly built up into a paying venture, is illustrated in the station at Berkeley, Cal., the interior of which is shown in the accompanying cut, reproduced by the permission of the Berkeley Herald.

In 1893 the town of Berkeley, Cal., after a profitless experience in running its own electric plant, advertised for bids for the lease of the plant and doing the city lighting. Two competitors for the contract — the Oakland Gas, Light and Heat Company, and the San Francisco Electric Company — made bids that were the same, but in the specifications of the latter were details advantageous to Berkeley, by reason of which the San Francisco company secured the contract. On September 11th of the year named, the San Francisco Electric Company, through Mr. J. Geo. Gardner, General Manager, secured control of the plant by effecting a combination with the Berkeley Electric Light, Heat and Power Company, and the reorganized concern, under Mr. Gardner's management, soon placed the enterprise on a business basis, and at present the investment is rendering satisfactory returns.



A Commercial Success from a Municipal Failure.

Among the first improvements made in the old installation was the placing of a new tubular boiler and an Eclipse Corliss Engine, each having a capacity of 200 horse power, and also the installation of two La Roche alternators, having an output of 36 amperes and 75 amperes, respectively, or a combined capacity of 2000 16 candle-power incandescent lamps. In addition, the plant operates 65 2000 candle-power arc lamps for municipal purposes from one 75 lamp 9.6 ampere Ball arc lighting dynamo. The incandescent service is rendered on meter rates, with the usual results, for it is found that although 2400 lamps are wired in on the circuits, the maximum load carried is but 800 lamps. The business is rapidly growing, and is quite satisfactory.

Correspondence.

ELECTRICITY IN PLANT GROWTH.

The original ideas presented in the article of Lieut. Stuart-Smith on "Electricity in Plant Growth, and Light in Chemical Decomposition," presented in the September number of the Journal of Electricity, are exceedingly important suggestions of the possible connections of observed effects, which seem heretofore to have been unconnected. The relation between the crop reports throughout the country, and the eleven-year sun-spot periods have long been noticed, although scientific men have felt that rather a coincidence was indicated than that there was any necessary connection between the two facts. Mr. Stuart-Smith has pointed out that the experiments of Prof. Warner, at Amherst, Mass., seems to give the connecting link between these observed effects, which have heretofore appeared to be so widely supported. Our meteorological observers have not made the observations necessary for the proof or disproof of Lieut. Stuart-Smith's hypothesis, though before such observations are likely to be undertaken it is necessary that a correlation of facts, already at hand, should indicate whether there is a strong probability that such observations would lead to important results. In the records of the astronomical observatories are to be found complete reports of the condition of the sun for a great number of years, and, since the establishment of Gauss and Weber of magnetic observations, many records have been preserved of the existence and character of magnetic storms. These two sets of data have been found to correspond with each other, and it is now definitely believed that the presence of spots on the sun exerts a magnetic effect on the earth, inducing strong earth currents. Whether the crop reports follow more closely the periodicity of the sun spots or of the earth currents has not been so clearly established. The variations in the actinic properties of sunlight, of which Lieut. Stuart-Smith speaks, are altogether unobserved as yet, and until definitely proved that there is a relation between the existence of spots upon the sun and the actinic activity of sunlight on the earth's surface, we will necessarily be in doubt as to whether the characteristics of the sunlight or the existence of earth currents has a greater effect upon plant growth. The practice of the market gardeners about the city of Boston of forcing their vegetables by lighting their garden with arc lights, would indicate that an actinic change in sunlight may probably be found to be more influential in plant growth than the presence of earth currents, though up to the present time experiments on a large scale have not been made in forcing plant growth by means of these currents. S.

San Francisco, October 17, 1895.

The Stirling Supply Company, 54 Second street, San Francisco, has secured the Pacific Coast agencies for the electric light and power apparatus of the Card Electric Company of Mansfield, Ohio, and of the Standard Thermometer Company of Peabody, Mass., manufacturers of the well-known Upton Arc Lamp.

In responding to advertisements please mention The Journal of Electricity.

A DEPARTURE IN ELECTRIC ELEVATOR CONSTRUCTION.

A new type of direct connected electric elevator, which presents several novel features of improvement over the ordinary form, has recently been brought out by Messrs. Cahill & Hall, of San Francisco, and which is shown in side elevation in Figure 1. The particular novelty consists in the way the hoisting ropes are operated, which forms a radical departure in that the hoisting ropes are not wound on a drum, as is the usual practice, but are moved by friction in much the same way that the cable of a cable railway, or the rope of the house mover, or the ship's hawser about a capstan are pulled. The principle upon which these appliances are operated is that so long as the free end of the rope about the capstan, for instance, is kept taut, the rope will keep its grip exerting an amount of pull dependant upon the power excited and the strength of the rope.

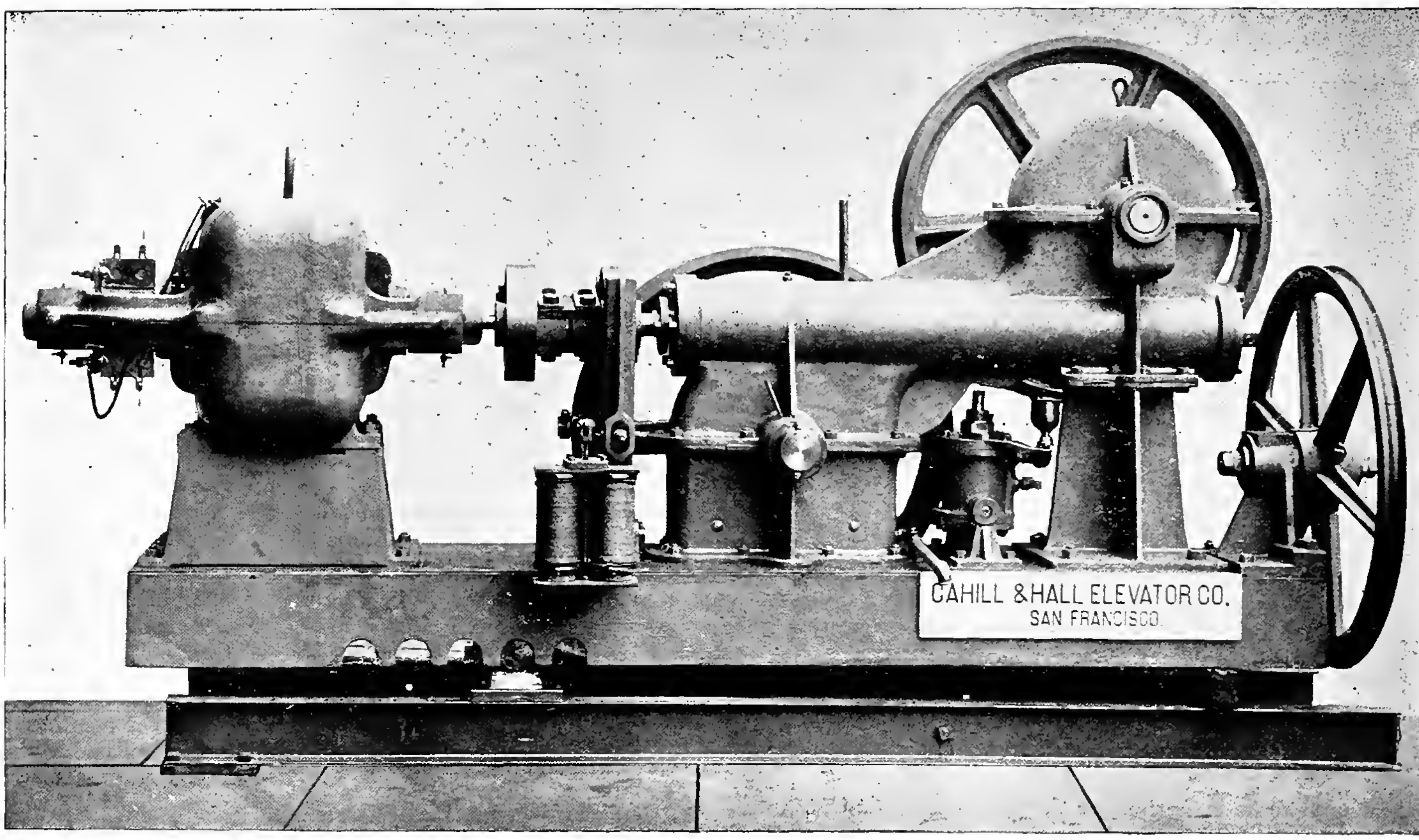


Figure 1—Departure in Electric Elevator Construction.

If, however, the free end of the rope is slack, the frictional contact of the rope with the capstan will be freed, and the rope will slip. This principle is executed in a novel way in the distinctive type of elevator designed by Cahill & Hall. It will be seen in Figures 1 and 2 that there are two hoisting ropes. One end of each of these is fastened to the top of a counter weight, whence they pass up and over a sheave mounted at the top of the elevator shaft, thence down along its side to and twice around these traction sheaves designated as C and C′ in Figure 2. From these traction sheaves the ropes continue down and around the front idler sheave C″, shown also in Figure 3, from which it continues up, and is made fast to the under side of the counterweight. The elevator cage is supported by four ropes leading from the top of the car over a sheave at the top of the elevator shaft, thence to the top of the counterweight.

The basic principles upon which the equipment operates may now be understood. As shown in Figure 2, the entire apparatus is rigidly mounted upon a bed plate, which being hinged as shown at Z, is free to tilt either way. The major portion of the weight of the apparatus however, is borne by the idler sheave C″, around which the equivalent of the free end of the rope passes. The weight of the equipment being borne on the rope through the sheave C″, furnishes the power for taking up the slack on the free end of the rope, and if the car meets with an obstacle preventing further travel, or if through any mischance the car should strike the bumpers at the top or bottom of the shaft, the rope will slip upon the traction sheaves, and all danger or damage will be averted. This is a feature which exists in no other form of electric elevator equipment, and is undoubtedly of great value, owing to the fact that with rigid connections between the rope and the winding drum, or between the rope and expansion or thrust sheaves, it is evident that in event of the car striking an unyielding obstacle, the momentum of the motor will impose fierce strains upon the machinery that ofttimes will result in breakdown, throwing the car upon the safety devices. To go more fully into the modus operandi of the Cahill-Hall equipment, as the front end of the apparatus is held up by the idler sheave resting on the hoisting ropes, it is clear that the measure of lift, which may be given to the machine, depends upon the amount of weight resting on the hoisting ropes, which of course is fixed by the weight of the equipment. If more pull is exerted on the hoisting ropes than there is weight resting upon them, evidently the machine will rise, which will slacken the ropes, and they will slip. By adjusting the weight of the machine, the equipment may thus be made to raise any predetermined load, any material excess of which will cause slipping, which the makers claim to be a most important feature.

In construction, the form of motor used resembles the waterproof type of the street railway motor to a considerable extent. It is therefore of the iron-clad frame type, and has two internal pole pieces. The particular feature that impresses one regarding the design of the

motor is the large amount of iron in the frame, and the entire absence of magnetic joints. The self-induction of the field circuits is very high, and the series coil is so proportioned that the self-induction opposes or chokes back the abnormal current flow that would otherwise occur at starting, because of the absence of counter-electro-motive force due to the armature being at a stand-still. The motor is equipped with self-oiling and self-aligning bearings; its weight is 2400 pounds, and its speed is 800 revolutions per minute.

Those who are familiar with the starting torque of various types of electric motors will appreciate result of a test made by Edward S. Cobb, mechanical engineer, upon the motor in question, and from his report it appears that a 15 horse-power motor having a ten inch armature exerted a starting torque of 2,448 pounds on the surface of the armature, and this with all the resistance of the rheostat thrown in, and with no material heating in either the rheostat or the motor.

The controller used is of the general disc type in which eliminates the use of a thrust bearing for the worm shaft, resulting in higher efficiency than would be the case with the use of but one gear. Further advantage is realized in this arrangement in that by having two gears, each will be called upon to carry but half the load, hence they will wear twice as long. The gears are filled with oil up to the center of the worm shaft, which insures perfect lubrication.

An equipment installed in the building of the Fred. J. Byrne Block, Los Angeles, Cal., is so geared that for each revolution of the armature the car travels five inches. The travel of the car is 55½ feet, and from tests made, this distance was covered in nine seconds each way. Twenty-two seconds were consumed in making the round trip, including starting and stopping, while fifty-five seconds were consumed in making a round trip with a stop at each of the five floors. To stop at each of the five floors allowing a man to get on and off the car in a way as near actual conditions of operating an elevator as is possible, required ninety

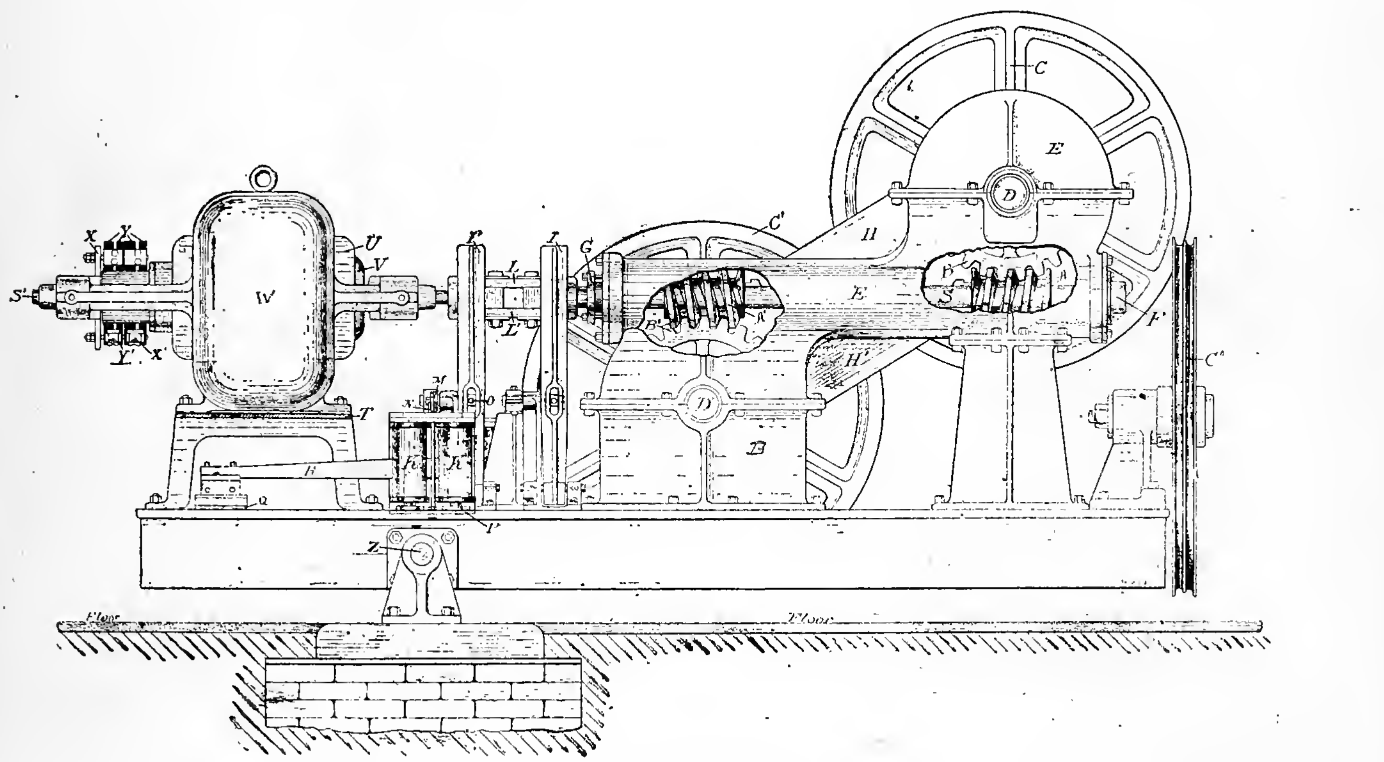


FIGURE 2—DEPARTURE IN ELECTRIC ELEVATOR CONSTRUCTION.

the lever consists of a straight bar insulated and swinging at the center, and which, therefore, acts diametrically, and brings the wipers in contact with strips so arranged as to give the connections necessary. All wipers and contact strips are made removable, and are manipulated by the lever in the elevator car.

That the motor performs its work well is evident by the smoothness and ease of both starting and stopping. The connections given for circuit changes are such as meet general conditions, but, of course, they may be modified in minor details to meet the necessities of different equipments. The motors are wound in standard voltages for 500, 250 and 110 volts, and, except in particular instances, motors having a rating of 15 horse-power amply satisfy all requirements.

It will be seen from the outline drawing in Figure 2 that the armature shaft is extended through insulating couplings L L′ to the worm shaft S, upon which is keyed the right and left hand worm gears A A′, which drive the main sheaves C C′ respectively. This arrangement

seconds for the round trip, all of which would indicate that the elevator was fully to the standard of any modern high speed hydraulic elevator.

The safety devices with which the system is equipped has been carefully worked out, and, in addition to all ordinary mechanical safeties, two sets of solenoids—one of which appears at K K′, the other being on the opposite side—have been placed for breaking the main circuit, and throwing on the brake I′ and I respectively. The solenoid controlling the brake I is wired in parallel with the shunt coil of the motor, and when excited releases the brake I by raising a heavy weight (not shown) which actuates it through an ordinary form of toggle joint. The solenoid K K′ operates similarly so far as mechanical effects are concerned, but is controlled through contact strips on the car, which make the circuit controlling the solenoid, and at the same time throw the brake I′ and cut the main circuit by raising the lever R, opening the main switch at Q. The main circuit being thus broken, current is taken off the motor, and

the second solenoid (not shown) which throws on the second brake I as described.

The San Francisco Savings and Loan Society has furnished interesting data concerning the advantage of

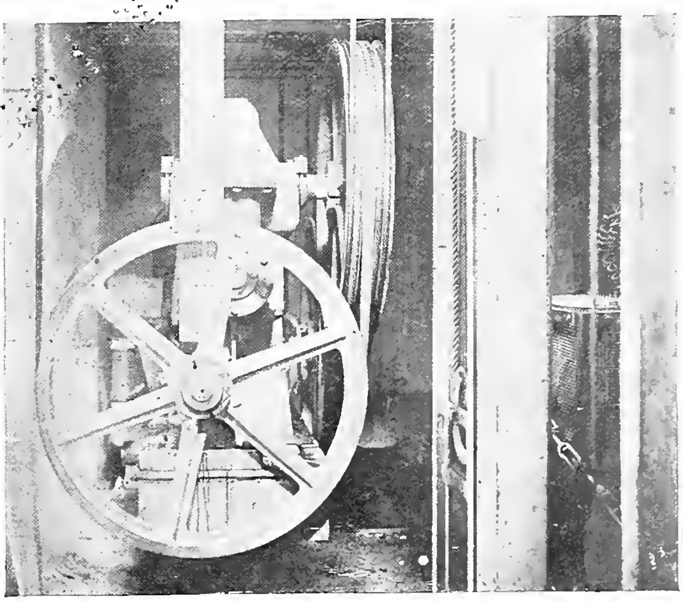


FIGURE 3—DEPARTURE IN ELECTRIC ELEVATOR CONSTRUCTION.

electric over hydraulic elevators. The hydraulic equipment displaced by the Cahill-Hall apparatus consisted of an ordinary vertical cylinder elevator, operated by pressure from the mains of the Spring Valley Water Company. The water consumed was measured by the travel of the elevator for the period stated, which averaged 12,931 feet per day, and the bills rendered from March 5th to August 5th inclusive, show an average consumption of 63,800 cubic feet of water per month, which cost an average of $118.71 per month, in comparison with which the bill of the Edison Light & Power Co. for electric service for the month of September, amounting to $20.80, shows a marked economy in favor of the electric elevator.

TOBOGGANNING OUTDONE.

A decided novelty in the way of an attraction for the amusement-loving public has recently been erected on a block near the Haight street entrance to Golden Gate Park, San Francisco, and which will doubtless be a material factor in increasing the business of the many street car lines of that neighborhood. The attraction consists of what may be termed a water toboggan, or a water chute. The chute proper consists of an inclined plane, 275 feet in length, and built with a rise of 25 per cent. Down this chute boats will shoot with accelerating velocity until the lake at the bottom is reached, when the voyagers will undoubtedly have had enough.

The entire outfit is operated by electric power from the trolley system, and the equipment consists of one twenty-horse-power slow speed multipolar motor for operating the elevators; one sixty-horse-power bipolar motor for driving a fifty-light arc dynamo; one G. E. 800-motor operating the hoist for pulling the empty boats up the chute, together with a pumping plant for keeping the chute well flushed with water. Already the city is flooded with posters asking "Have you shot the chutes?" and before long many San Franciscans will have experienced the fact that there is something new under the sun.

The Trade.

JOHN M. KLEIN'S ELECTRICAL WORKS.

There are hundreds on the Pacific Coast who will be pleased to learn that John M. Klein's Electrical Works has so increased its business as to necessitate moving to a large three-story building, Nos. 421–3 Montgomery street, San Francisco. The present quarters are near California street, in one of the busiest portions of the city, and the establishment having taken the entire building, will fit up the basement as a packing room, the first floor as a store and salesroom, the second floor as a warehouse, and the third floor as its factory, making it one of the most complete electrical manufacturing and supply houses on the Pacific Coast. This removal at once centralizes the various interests of the concern by bringing them under one roof in the best business portion of the city.

The history of this establishment is one of singular prosperity. Mr. Klein started in business with the Western Union Telegraph Co., in New York City, in 1869, as a messenger boy, in which capacity he proved so faithful that in the following year he was given a position in the old Western Union shops on West Fifty-fifth street, where he became a shop mate of many of the veteran telegraphers, among whom were John Gough, A. J. Brown, Charles Bender, George Thompson and others. For many years he remained in the factory, and then came to San Francisco and entered the fire alarm service, where he remained until 1880, when he started in business for himself, his only capital being a well-equipped set of tools and a thorough understanding of the art. An idea of the degree of success attained may be had from the fact that the mercantile rating of the electrical supply house of John M. Klein's Electrical Works is as high, if not higher, than any other similar establishment on the Pacific Coast. Though the firm still embraces Mr. Klein's individuality, the firm has recently been enlarged by the addition of the name of Mr. Marion L. Mowry to partnership, as a result of which the business is being pushed to the utmost degree.

Mr. Mowry, who is a native of California, is well-known in district messenger and electrical circles. He was the founder of the California District Messenger Company in 1882, and the first to start opposition to the American District Messenger Company of San Francisco. In various ways he has been connected with electrical projects, and recently became interested as above stated.

ECHOES OF THE CARNIVAL.

Sacramento City has again assumed its workaday attire, and most, if not all, of the electric lighting equipment erected by the Carnival Committee for decorative purposes has been disposed of at private sale. It now transpires that a single supply house in San Francisco furnished over 14,000 lamps for the Carnival, and an equal number were obtained from other sources. The remaining equipments in the Folsom Power House of the Sacramento Electric Power and Light Company have been completed, as has also the sub-station, and the system is working to entire satisfaction.

Through inadvertence no mention was made of the fact that credit for a great amount of work on the arches and other illuminating effects for the Carnival was installed by the Pacific Electrical Works. This is one of the oldest electrical supply and construction establishments in Sacramento, having been established under the management of C. A. Fisk in 1874, and its store at 1023 Fourth street forms a headquarters for everything electrical.

A NEW IDEA IN TAPE.

The Okonite Company (Limited), always progressive and leaders in all that pertains to their especial line of goods, brought a new idea in tape to the recent street railway convention which created a genuine sensation and caused any amount of favorable comment. The novelty consists of a new form in which the company is putting out the celebrated Manson Tape, and was shown by Captain Willard L. Candee, who was to be found here, there and everywhere, surrounded by an interested group of the electrical fraternity eager to get points on the "good thing."

The usual manner for supplying the trade with tape has been for the manufacturers to put it up in half-pound packages or rolls, incased in tin foil or other wrapping. It is the general experience of most companies that the linemen in using tape so put up, after taking what was needed for the work in hand from the roll, would throw what was left away, or, if they did put it back into their kit, the wrapping would soon become loose, the tape gather dust and dirt, and in a short time become almost unfit for further use.

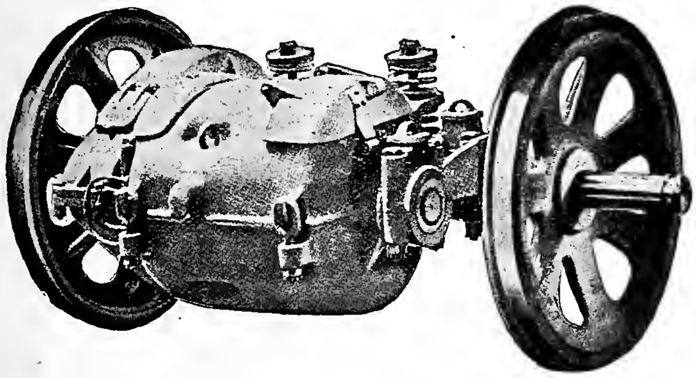
Captain Candee showed the Manson Tape, packed in round tin boxes of two colors—red and white—both very attractive and neat in appearance, and containing one ounce of the tape. This is, nine times out of ten, a sufficient quantity for any ordinary repair, and if there be any left over it may be put back into the box, which is conveniently small (about the size of a silver dollar), where it will be kept fresh and clean and ready for further use. The new form of packing meets an evident want, and will unquestionably mean a considerable saving to the companies and prove a great convenience to linemen.

The Manson Tape is furnished in two colors; the black tape will be put up in red boxes lettered in black, the white tape in white boxes also lettered in black.

Captain Candee returned from the convention with a large number of valuable souvenirs in the shape of substantial orders for the novelty. It is of interest to state that the tape put up in this way adapts itself perfectly to the needs of cyclists as well, and will doubtless prove as popular in that quarter as for purely electrical uses.

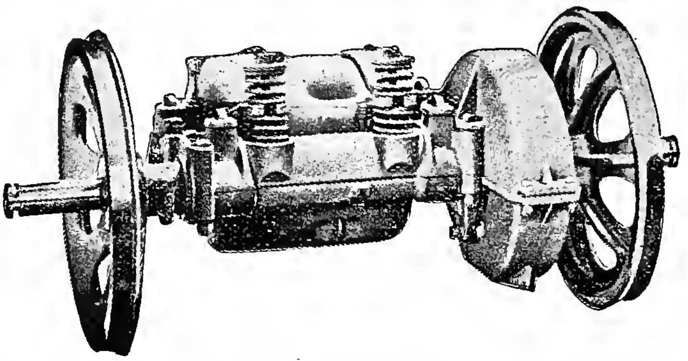
THE WALKER STREET RAILWAY MOTOR.

The latest type of motor manufactured by the Walker Manufacturing Company, is that shown in the accompanying illustrations, and which at once combines all features that have been found of value. It is of the four



Walker Street Railway Motor.

pole single reduction steel frame type, is of light weight, considering the output, and is in no way attached to the axle except through the springs, which at once practically eliminates the serious items of repair to both track and equipment, consequent to the hammering on the track and rail joints due to rigid suspension. The motor is entirely water and dust proof, and may be conveniently opened from below, which retains the armature in the top half of the casing or by the removal of only two bolts, the armature may be lowered with the bottom half. The armature is of the toothed-drum type, provided with machine-wound, interchangeable coils. The



Walker Street Railway Motor.

field coils, which are also machine wound. can be readily removed from the frame, and the shaft is unusually heavy with extra large and long journals, while the gears are run in oil in a detachable air-tight casing run in oil. Insulation is effected by the use of mica throughout, and every motor is tested at 5000 volts a. c. A series parallel controller is used, which takes up an exceedingly small portion of the care platform, is both fire and waterproof, and all parts are easy of access for inspection.

The Pacific Coast Agency of the Walker Manufacturing Co. has been placed with the Adner Doble Co., Mechanical and Electrical Engineers and Contractors of Nos. 13 and 15 Fremont street, San Francisco, who report the sale of a 400 horse-power multipolar Walker generator to the Oakland Consolidated Street Railway Company, and of fifteen street railway equipments to the Sutro Railroad Company.

WROUGHT STEEL BOILER CONSTRUCTION.

The recent installation of 600 horse-power of new wrought steel construction safety boilers by the Babcock & Wilcox Company in the power house of the Sutro Railroad Company, together with the erection of 200 horse-power of boilers for the Commercial Steam Power Works, and 60 horse-power for the Hebrew Orphan Asylum in San Francisco, have received close attention by parties who are interested, as the high character of workmanship on the forged parts and drums is something unusual. These "W. S. C." boilers, as this type is termed, have forged steel heads, cross boxes and drum-heads, and are designed for exceptionally high pressure. Mr. Charles C. Moore, the Pacific Coast Manager, has received for distribution among steam users two interteresting pamphlets, entitled "High Pressure" and "Facts." The former specially describes boilers of the "W. S. C." construction, and the latter gives a history of water tube boilers from the inception of the art of steam boiler construction to the present time, indicating the degree of commercial success attained by each.

Messrs. Charles C. Moore & Co. also report recent equipment of thirty steam plants in this section with Stratton Steam Separators and of more than forty plants with Bundy Tank and Return Steam Traps, the latter being a comparatively new device of special economy for returning condensed water direct to the boilers without pumping. Satisfactory sales of Goubert Feed Water Heaters, New York Safety Engines, Snow Steam Pumps and Spencer Damper Regulators are also reported.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

The transmission of electric power is no longer a speculative experiment but a plain business proposition, that commends itself to intelligent investors everywhere.—Santa Cruz (Cal.) Surf.

While capitalists of the State are looking around for electric power, we beg to call their attention to Merced Falls, in this county. If the power there is harnessed up and properly utilized it will produce handsome returns on the investment.—Merced, Cal., Express.

The business boom in the electrical world continues and new schemes for power transmission and other electrical enterprises are being formed, while hustling promoters of other schemes a little older are figuring on the cost of plans and trying to raise capital.—San Francisco Call.

It is not easy to foresee all that this [electric transmission] may mean for the near future, particularly here in the Salt River valley. If the water power which we have could be utilized for generating electricity, there would be no end to the possibilities. —Phœnix (Ariz.) Republican.

Matters in the [municipal] electric light department are still mixed. When the incandescent plant was put in operation things got in a tangle which it seems impossible to straighten out. A number of stores and residences are furnished with lights, but the profit accruing to the city has not as yet been discovered.—Alameda (Cal.) Argus.

The work of harnessing the vast water power of California, most of which is now going to waste, has evidently begun in good earnest. The American River plant at Folsom is already furnishing power for Sacramento, twenty-three miles away. * * * Similar projects are on foot in other sections, and each one will probably prove a highly remunerative investment.—Los Angeles Times.

It is suggested that if the National Republican Convention be held in San Francisco next June, Sacramento might hold at that time a flower carnival, or Electric Carnival, or similar celebration, for the purpose of attracting and entertaining the Easterners. If Sacramento does anything at all, let her have next year another Electric Carnival, for in that direction she can give a pageant unique in its character and which no other city at present can dupliaate.—Sacramento Bee.

It is practicable to pick up Nature's immense stores of power, as represented by the innumerable mountain streams throughout the land, and transport them to the centers of trade, commerce and manufacturing, and convert them to the uses of mankind. Instead of taking the manufacturing establishment to the power, which is often in places difficult of access, the power will be carried whither the manufacturer wills. He will build his factories where they will be easy of access to transportation, and bring the power of the mountain streams to them. And this is not an idle dream—it is not a dream at all, but an established, practical reality.—Nevada City (Cal.) Herald.

In California there is no Niagara to harness, but there is a steady fall of water from the Sierras capable of furnishing more power than will be needed for generations to come. A practical beginning of utilizing these streams has already been made, and it will be a misfortune for San Diego if it fails to become a competitor for these future manufactories. The mountain streams only a few miles distant can be made to furnish ample power at moderate cost. The facilities for transportation by water render this city a much more desirable place for manufacturing establishments than interior points. The subject is certainly one worthy of careful consideration.—San Diego (Cal.) Union.

There is no limit to the possibilities that lie before manufacturers and others who depend upon the creation of some form of force. Electricity is the coming motive power, but electricity must be caused by some exciting agency and to-day the usual means is a steam engine which turns the armatures of dynamos and so produces the current that is then used for lighting and various purposes. But this depends upon coal, and coal is neither cheap nor plentiful in California. Hence, our salvation is in the means of utilizing our streams. * * Some of our local capitalists have recently examined a canyon near Healdsburg, which they think will solve the problem for Santa Rosa. The canyon is twenty feet higher than the Russian River. The plant, it is estimated, will generate from 2,000 to 5,000 horse-power, and it is expected that with additional turbines and canals running out of the initial dam at least 10,000 horse-power can be derived.

Enthusiastic citizens here are declaring that in a short time Sonoma County and the entire State will be the scene of prosperous factories run by this new power so cheaply obtained from the hills.—Santa Rosa, Cal., Democrat.

When power for the generation of electricity for transmission is under consideration, Stanislaus County looms far above all other sections of the State. The great irrigatfon dam at La Grange affords advantages in this direction that are simply stupendous. Light, heat and power could be furnished to Merced, Modesto and Stockton on the plains, as well as the lesser towns, and to Coulterville and other towns of the mountains. An electric railroad from Modesto to Coulterville would make this city the base of supplies for the mining town and all adjacent country, as well as give us all the traveling and transient business, a very valuable consideration. The cost of constructing and equipping such a road would not be excessive, and the enterprise would pay its promoters and handsomely enhance the business of the town. —Modesto (Cal.) Herald.

H. W. Gray, the contractor who built a portion of the ditches of the Modesto and Turlock irrigation district, says: "There is already going to waste power enough for the submerged dam on the Tuolumne river to operate an electric railroad from there to Stockton on the north and to Fresno on the south. That dam was built by the Modesto Irrigation district. It is in the Tuolumne river and about thirty miles from La Grange. It is 126 feet in height, and supplies 2100 cubic feet of water per second for the district. The district will probably use not more than 1000 cubic feet per second. At the driest season of the year there is 200 cubic feet of water per second. There is a dam already built, with water flowing over it at a height of 126 feet, which would furnish all the electric power needed to operate a railroad from that point to Modesto, and then on either side to Stockton or to this city. As it is now, the power of that mighty force of water is going to waste. That dam is only one of many which may be built for the purposes of irrigation, which may also be used to generate electric power for railroads. The whole western slope of the Sierra Nevada drains an almost incalculable amount of water, which is gathered according to the watersheds into creeks and rivers. There is the Merced River, which has fall enough to supply enough power to operate an electric road to a point on the Bay of San Francisco. The same is true of the Fresno River and the San Joaquin, the King, the Tule and the Kern Rivers. All those are great rivers with capacity of generating great power, which may be used for electric roads or for manufacturing plants"—San Francisco Chronicle.

California cannot be too prompt to make commercial use of the power in her streams to provide it with electricity. The first great experiment—on the American river at Folsom—is successful. A hundred other schemes for putting traces and collars upon the moving waters are in the air. From Lake, from San Diego, from Kern, from Calerveras come reports of projects to make the waters do the hard work for man. Use of water for power for the electric road to be built to the Yosemite Valley is entirely within possibility, and the visitor to the wonderland may ride swiftly by the force of the very waterfalls that enchant his vision at the end of the trip.

The Directors of the San Francisco and San Joaquin Valley Railway would not be wasting time by giving consideration to the feasibility of the use of electricity as the motive power for its trains, and to investigating how power may best be obtained from the Stanislaus, the Tuolumne, the Merced, the King and the Kern. The topography of the country through which the Valley Railroad will run its way is peculiarly adapted for an electric railway, and nowhere else in the world has nature placed the power more accessible. One of the reasons for selecting the Nantasket branch in Connecticut as the line for experiment is that within its short limits are condensed most of the difficult problems which will have to be solved before electricity can be recognized as a successful substitute for steam. The grades are steep and the curves sharp and frequent. The Valley Railroad will run through a level valley, and will be free from either steep grades or sharp curves.

The electric locomotive has but to be developed one degree further to be ready for use on just such a railroad, and, in the mean time, California should be preparing to receive the locomotive. The union of the largest factory in the world for supplying motive engines with an electrical company means more than speculation for constructions for suburban roads. It means that the great railroads are going to turn their attention to electricity. The change from steam should come first where natural power can best be applied.—San Francisco Examiner.

Reports of the Month.

LITIGATION.

Spokane, Wash.—The Union Light and Power Company has been defeated in its suit to enjoin the City of Spokane from interfering with the construction and maintenance of its lines.

Seattle, Wash.—The City Council has passed an ordinance requiring all electric wires put underground inside of ninety days. All electric companies, together with many prominent business men, have signed a petition to the Council, in which the electric companies agree to use but one pole line on either side of each street, with six poles to the block, and that all other poles shall be cut down.

COMMUNICATION.

Fresno, Cal.—The Sunset Telephone and Telegraph Company has completed and is now occupying a vitrified clay underground conduit system covering that portion of the city bounded by Fresno, Kern, I and N streets.

Sacramento, Cal.—The contract for the 12,000 feet of ærial telephone cable required by the Capital Telephone and Telegraph Company was secured by the John A. Roebling's Sons Company, and the material has been delivered and is in use.

San Francisco, Cal.—R. B. Elder, Pacific Coast agent for the Chloride Company, reports the sale of several storage battery plants, among which is one of thirty-six cells of chloride battery for operating the new Express Exchange for Sacramento.

TRANSMISSION.

Riverside, Cal.—The Board of Trustees has advertised for bids for electric power purposes.

Redwood City, Cal.—Efforts are being made to operate the new electric plant here by water power.

Kennedy, Nev.—The Schweitzer Electric Milling Company is erecting machinery to work custom ores.

San Diego, Cal.—F. S. Hartwell has been appointed agent for the Walker Manufacturing Company for San Diego county.

Visalia, Cal.—The Kaweah Irrigation and Power Company is purchasing a complete outfit for excavating the proposed power canal.

Bodie, Cal.—The Standard Consolidated Mining Company has completed the big dam for its electric power station at Green Creek.

Bakersfield, Cal.—Alfred Billing has filed a claim for 35,000 inches of water of Kern River, to be diverted at a point in Section 17, Township 27, Range 32.

Waneta, Wash.—The Kootenay (Ida.) Hydraulic Mining Company has altered its plan, and instead of furnishing water for mining purposes, proposes to place an electric plant and furnish electric power.

Woodland, Cal.—The Rumsey and Tancred colonies are considering the advisability of putting in an electric transmission plant to furnish power for pumping water from Cache Creek to be used for irrigating the Tancred colony and the surrounding country.

San Francisco, Cal.—The Pacific Coast office of the Westtinghouse Electric and Manufacturing Company reports the sale of the following apparatus during the month: 1 2½ horse-power 500-volt multipolar motor; 1 7½ horse-power 500-volt multipolar motor.

Flagstaff, Ariz.—Yuma capitalists will soon begin the erection of a large smelting plant at Castle Dome for the reduction of the lead and silver ores from the mines near that place. Electricity for the works will be furnished by water power taken from the great Yuma irrigating canal.

Salt Lake City, Utah.—R. M. Jones, Manager of the Big Cottonwood Power Company, has returned from the East after having ordered a complete transmission plant for the company. Mr. Jones will now devote his time to the management of the company during period of installation.

Sonora, Cal.—It is reported that local capitalists, believed to be the Sonora Electric Light Company, intend to build a dam across the north fork of the Tuolumne river, near Duck Wall Canyon, about five miles from Somersville, for the purpose of developing additional electric power.

Victoria, B. C.—F. S. Barnard, who has just returned from London, says that he has succeeded in obtaining capital to the extent of $500,000, for the purpose of developing the water power of Seymour Creek, and thereby generating electricity for electric lighting and electric railways in Vancouver, New Westminster and vicinity.

Los Angeles, Cal.—The San Gabriel Power Company proposes to take the entire flow of the San Gabriel river out of its bed eight miles above the mouth of the Azuza Canyon, and by conveying it through a tunnel to develop a fall of 400 feet. This tunnel will be about 1000 feet long and is already half completed. The promoters are W. C. Kerckhoff, A. Haas and others of this city.——A recent survey of the proposed transmission line for the Kern River and Los Angeles Electric Company shows that its length is under 110 miles. Between the reservoir on Salmon creek and Kern river, a distance of eight and a half miles, there is a fall of about 5,100 feet, there being one waterfall of 2,000 feet.——W. N. Myers has purchased a 400-horse-power electric plant to furnish power to pump the wells in the oil fields.

San Francisco, Cal.—The Pacific Transmission Company has been incorporated for the purpose of generating electric power from the refuse coal at the Corral Hollow coal mines in Alameda and San Joaquin counties, for transmission to the cities of Stockton, San Jose and elsewhere. Eight hundred thousand dollars have been invested in developing the mines, and it is stated that the initial plant will generate 5,400 horse-power. Messrs. James and John Treadwell and others, among whom are representatives of the General Electric Company, are the incorporators. ——The Merced Falls Electric Power and Manufacturing Company has been incorporated by J. P. Flemming and others, with $1,000,000 capital.——The Westinghouse Electric and Manufacturing Company reports the sale of one 45 kw. two-phase and one 60 kw. single phase plants.

Fresno, Cal.—The contract filed by the San Joaquin Electric Company, with the County Recorder for the purchase of electrical apparatus from the General Electric Company, describes technically the machinery and supplies called for, the cost being $113,500. About 400 miles of copper wire must be furnished, together with 1000 incandescent lamps, 160 arc lamps, and the various machinery heretofore described. The San Joaquin Company has accepted the county franchise with the understanding that the entire work is to be completed within one year. About 150 men are at work on the dams and ditches of the company. These are now about completed, and the work of grading for the pipe line and power house site is in progress. The poles for the thirty-five mile transmission have been ordered, and work on the pole line will be commenced by October 15th. The initial capacity will be 1040 kilowatts in three units; 4100 feet of pipe line must be laid, which will develop water power under 1410 foot head.

Grass Valley, Cal.—The contract for stringing the wire for the Nevada County Electric Power Company has been awarded to the Electrical Construction & Repair Company, of San Francisco. The basis of the contract is the stringing of seventy-two miles of bare copper wire of various sizes over pole lines already erected, and at the top of the pole a circuit of No. 8 iron wire, which is broken and grounded at every other pole. The pole line starts out from the power house at a grade of forty per cent. About 30,000 feet of lumber is being received daily, and is being placed in the flume of the Nevada County Electric Power Company. This flume will be 18,400 feet in length, and is now about two-thirds finished, and will be entirely completed by the middle of October. Only a few weeks more work will be required on the dam, which is being constructed of heavy granite logs and concrete. A new road has been built to allow the hauling of dynamos, water-wheels and lumber to the site of the power house, and no delay is occurring in any branch of the work.

ILLUMINATION.

Fort Jones, Cal.—It is expected that an electric light plant will be installed here.

Yuma, Ariz.—An electric light and pumping plant is soon to be placed in the prison.

Long Beach, Cal.—The Long Beach Electric Light Company will soon extend its service to San Pedro.

Phœnix, Ariz.—A 250 light plant is being installed in the insane asylum, together with a pumping outfit.

Santa Barbara, Cal.—Negotiations are nearly consummated for a 1000-light generator for the town of Santa Maria.

Prescott, Ariz.—Arrangements are about completed for the installation of another electric light plant of 2000-light capacity.

Santa Cruz, Cal.—C. Osborn has been appointed to succeed C. E. Lilly as superintendent of the Electric Light and Power Company.

Pasadena, Cal.—Bids and specifications have been received by the Electric Light and Power Company for an additional 150-horse-power boiler.

Benicia, Cal.—The old engine and dynamos of the Napa Electric Light Works have been moved to Benicia, where they will be used to furnish light for that city.

Woodburn, Or.—Davis Brothers of Silverton are canvassing this place with the idea of securing sufficient business to warrant the installation of an electric lighting plant.

Napa, Cal.—The electric lighting franchise recently secured by L. A. Grothwell has been assigned to a new company known as the Napa and St. Helena Electric Company.

Salinas, Cal.—The Salinas Gas and Water Company has accepted the proposition of the Common Council for seven additional street arc lights, at $7.50 each, for fifteen months, and will place same immediately.

Grass Valley, Cal.—The North Star Mining Company has installed an incandescent lighting plant, consisting of a 100-light dyamo of the Electrical Engineering Company, operated from a 10-horse-power Girard water wheel.

St. Helena, Cal —The General Electric Company will install an electric lighting plant for the Napa and St. Helena Electric Light and Power Company, and are now at work laying out a complete system of wiring for the town.

Sonora, Cal.—Grant & Bannister are to install a 500-horse-power electric light and power plant, to be completed by February 15, 1896. Wires will be run through Sonora, Columbia, Jamestown and other towns for lighting purposes.

Wattsburg, Wash.—J. G. Stevens has secured a franchise to erect an electric light plant, and will begin work at once. Power will be furnished from Washington Mills temporarily, but eventually Mr. Stevens will take out a mill-race of his own.

Tacoma, Wash.—The Board of Public Works intend to increase the electric lighting plant by the addition of a new 125-horse-power boiler, a 2000-light alternating generator and a 250-horse-power engine, the generator and engine to be second-hand, if the same can be obtained. The plant is now supplying 580 arcs and over 3000 incandescents.

Anaconda, Mont.—The Anaconda Electric Light and Power Company are building a new power house, which will be fitted out with a new outfit of water wheels, dynamos, etc. Four new Leffel turbine wheels and a Cascade wheel will be used, directly connected to the dynamos. A Brush generator will furnish arc lights, and a Westinghouse the incandescents. A storage battery will be placed in Carroll.

San Leandro, Cal.—An ordinance stating the necessity of putting in an electric light plant has been referred to the Ordinance Committee, and as the price of such a plant would be too great for the city funds, it has been proposed that bonds be issued. A bid of $2,383.60 has been received from the Best Manufacturing Company for furnishing power for an electric light plant, and for installing the electric plant the following bids: California Electrical Works, $4,458.20; A. C. Rowlands, $7,183.

San Francisco, Cal.—It is reported that the recent Eastern trip of J. B. Stetson, President of the North Pacific Coast Railroad and also of the Edison Light and Power Company, was in connection with electric light matters. It is understood that Mr. Stetson's object is to meet the threatened competition of the San Francisco Gas Light Company by engaging in the gas business, and Professor Stewart is authority for the statement that the present plant of the gas light company, which cost $12,000,000, can be duplicated for $3,000,000. It is rumored that the electric company has under consideration the adoption of the professor's ideas and intends to manufacture gas at rates lower than it has ever been believed possible to make it.——The Merchants' Association is advocating the lighting of Market street with arc lamps, and the daily papers are urging the Park Commissioners to install an electric plant for lighting Golden Gate Park.——W. J. O'Connor has relinquished the agency for the Sunbeam Incandescent Lamp Company and now holds the Pacific Coast selling agency of the Buckeye Lamp under the California Electrical Works.

TRANSPORTATION.

Pasadena, Cal.—T. S. C. Lowe has been granted a franchise for an electric railway connecting with the Pasadena street car system and the mountain railway at Altadena.

St. Anthony, Idaho.—Engineers are at work surveying for a road to be built from this place to the nearest point on the Utah & Northern, a distance of about twenty-seven miles.

San Diego, Cal.—The General Electric Company has secured the contract for equipping the San Diego Cable Company's road with electricity. The contract includes dynamos, cars, trolleys and all other appliances.

Redlands, Cal.—E. G. Judson, one of the committee of the proposed electric street railway, has figured the cost of equipment at about $8000 per mile. The length is five to six and a half miles, the cost being $40,000 to $65,000.

San Jose Cal.—Messrs. L. M. Hale and J. P. Pfetch have submitted a proposition to the Board of Trade to build a first-class road between San Jose and Saratoga and Congress Springs. A committee of the Board of Trade endorses the proposition, and urges that the property owners, in vicinity of the proposed road, subscribe $50,000, but no money will be paid until the road is in satisfactory operation.

Haywards, Cal.—Surveys have been finished on the San Leandro and Haywards branch of the proposed electric road from Oakland to Livermore. Surveyors are also at work on other portions of the road, but no route has been accepted.

Phœnix, Ariz.—Lincoln Parlor has been granted a fifty-year franchise for a standard gauge railroad to be operated by horse, electric or steam power on Van Buren street and Woodland avenue, from the center of Seventh avenue westward to the city limit.

Santa Barbara, Cal.—The Santa Barbara Consolidated Electric Bailway Company is now at work on its road to extend from State street along Haley street to the County Hospital, and expects to extend the road through the principal streets in the near future.

Seattle, Wash.—A new power-house is being built for the Seattle Consolidated Street Railway Company, new cars have been ordered, and rails for Second street were shipped from Chicago. The company will spend over $100,000.——The Seattle and Tacoma Electric Railway scheme is being revived.

Salt Lake, Utah.—O. B. Hardy and W. J. Moorhead have applied for a franchise to build an electric plant for furnishing light and heat, and maintaining and operating electric railroads in the West Mountain mining district. They agree to light the jail at Bingham, during the life of the franchise, free of cost to Salt Lake County.

Oakland, Cal.—The General Electric Company have received the contract to equip the Piedmont division of the Mountain View & Piedmont Railroad Company with electricity. Seven new cars will be run through from Piedmont to Seventh and Washington street. The cable track to Piedmont will be kept in repair, and the cable will probably be operated Sunday afternoons, when it is necessary to carry more passengers than the electric cars will accommodate.——The Haywards Electric Railway Company ran special trains from this city to Haywards during the recent bicycle road races. These trains had the right of way, and, as the track runs along the road used as the race course, hundreds of people took advantage of the opportunity offered to keep pace with the racers.——The Oakland Street Railway Company submits applicants for positions to a rigid written examination.

San Francisco, Cal.—The San Francisco and San Mateo Electric Railway Company has applied for a franchise to extend its Park branch from the present terminus at Stanyan and Waller streets, along Stanyan to Sullivan, to J, to Ninth avenue, and thence through the old San Miguel Rancho to Ingleside.——C. Stein, the tie-plate expert of the Q. & C. Co., of Chicago, who was at the Palace Hotel, is superintending the placing of several millions of tie-plates on various electric and steam roads throughout the Coast, among which are the Los Angeles Consolidated Electric Railway Company, the Southern Pacific, the San Francisco and San Joaquin Valley, and the San Francisco and North Pacific Railway Company. Mr. Stein is now in Mexico.——The Abner Doble Company are installing fifteen double 25-horse-power Walker equipments on the 38-foot combination cars of the Sutro Railroad Company, the installation aggregating 1500 horse-power. These cars are each guaranteed to haul a 28-foot trailer up a 11 per cent. grade at five miles per hour, when loaded with 180 passengers on the car and 150 passengers on the trailer. The Westinghouse E. & M. Co. has sold 48 horse-power in small motors to the Sutro Railroad Co.

Los Angeles, Cal.—The Main Street Railway has been purchased by a San Francisco syndicate, which proposes to equip the entire road with electricity.——The Los Angeles Traction Company is extending the terminus of its road to University station, as follows: From Freeman street, the present terminus, along Hoover street, Forrester avenue and Vermont avenue to the University station. Other extensions are projected in the near future.——The Los Angeles Electric Railway Company has sold its bonds, and is now ready to commence work on the Altadena extension.——Prof. Lowe has applied for a franchise to operate an electric railroad from the corner of Raymond and California streets to Broadway. The road will be built without delay.——R. F. Clark and associates have been granted an electric railway franchise over various streets commencing with the intersection of Main, Spring and Temple streets, and terminating at the intersection of Mission Road and the city limits. Another franchise has been granted to T. C. Paxton for an electric road to commence at the intersection of Hill and Eighth streets, running thence along Hill to Sixteenth, to Figueros, to Sixteenth, to Georgia Bell street.——By January 1st, 1896, there will be an electric street car line starting from the corner of Fourth and Spring streets to run through Hollenbeck Park.—— The Pasadena and Pacific Electric Railway Company has awarded the contract for the trolley and feeder circuits for its line from this city to Santa Monica to the John A. Roebling's Sons Company. The length of the road is twenty-two miles.

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The Nevada County Power Transmission.

FIGURE 1.—*On the Slide.*

THAT the installation of electric power transmission plants in the mountainous mining regions of the Pacific Coast is attended with many unforseen difficulties other than electrical, is shown in the interesting plant now being erected in California by John Martin under contract for the Nevada County Electric Power Company. So typical is this undertaking of electric installations in mountainous countries, that a description of the means resorted to for handling the heavy machinery will be both interesting and instructive.

The plant under consideration is to be driven by water power, mainly derived from the south fork of the Yuba River, at a point 18,400 feet above the site of the power house. At this point a cribbed log dam, twenty-six feet high and seventy-eight feet wide, illustrated in Figure 4, has been erected. Inasmuch as the Yuba River at this point constitutes a torrential stream during the winter season, the utmost care was necessitated in the erection of a log dam to withstand the floods of each winter; accordingly a site walled in by solid granite was selected for the dam and the diverting flume shown in Figure 3 was built to carry off the water from the natural bed of the river, in order that each log might be bolted to bedrock and to each other. From the completed dam is run the flume shown in Figures 3, 4 and 5. This is five by six feet in size and has a capacity of 5,950 miners' inches. One and one-quarter million feet of pine lumber was used in its construction, which consumed the labor of 110 men for four months. Continuing, as the flume does, mainly along the granite bluffs confining the river, its construction was a task of great magnitude, involving the exercise of much engineering skill and risk of life on the part of the workingmen. The construction of the dam and flume was done under the supervision of Mr. Alf. Tregidgo, who from the outset has been foremost in the undertaking.

The flume terminates immediately above the power house on an exceedingly steep incline known as "The Slide," which, together with the power-house site, is illustrated in Figure 2, giving the water a head of 206 feet. From the penstock of the flume steel-riveted pipes, 320 feet in length, are to be carried down, the first 120 feet being of forty-eight-inch pipe, and the second and third 100 feet being forty-four and forty-two-inch pipe respectively. The pipe line terminates in the large steel receiver (Figure 8), which will supply water to the two sets of Pelton wheels operating the generators. This receiver is nineteen feet in length and forty-eight inches in diameter, weighs approximately four tons, and

FIGURE 2.—*The Slide and Power-House Site.*

constitutes the largest though not the heaviest piece of apparatus used.

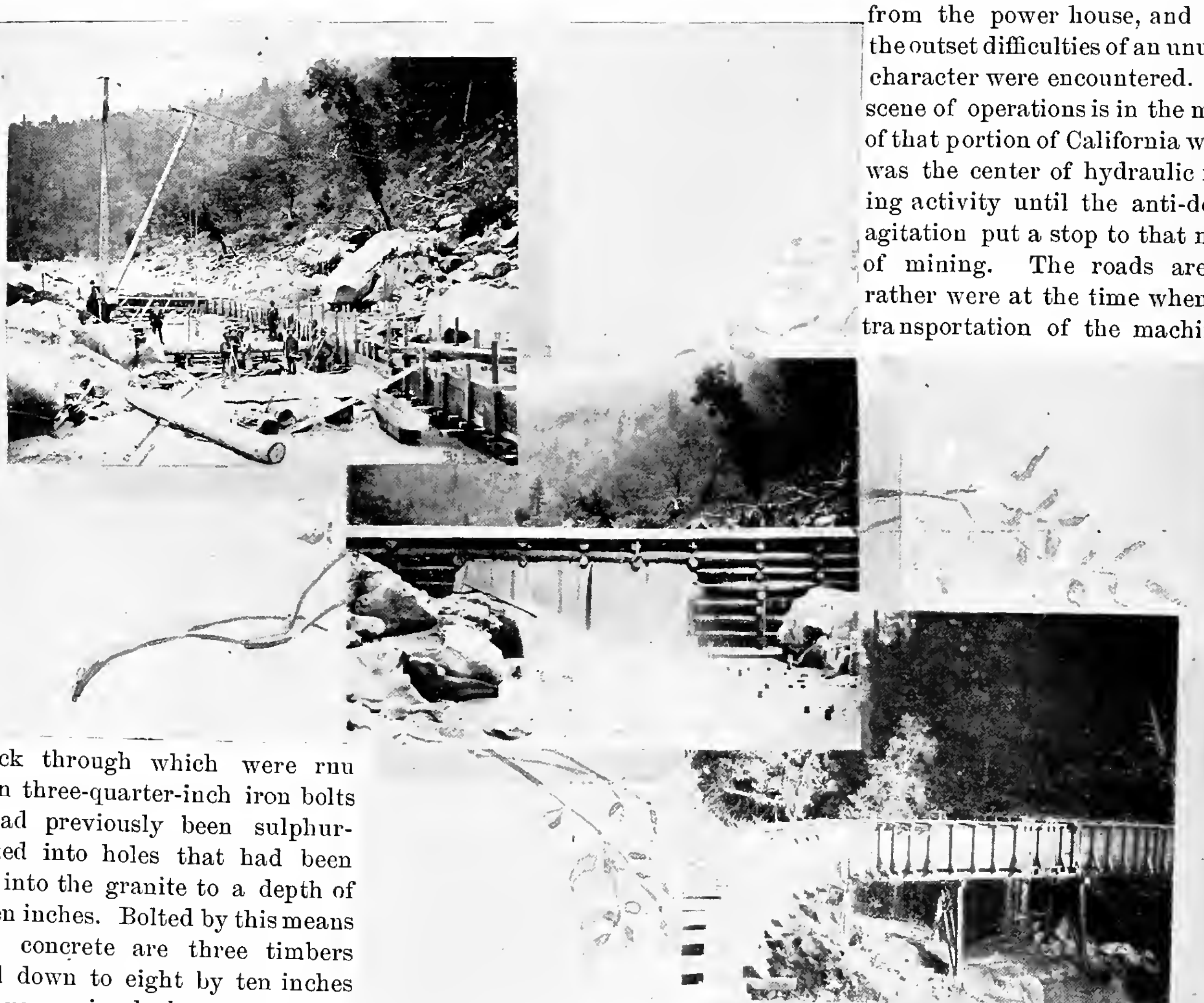
As indicated, the power is derived from two sets of Pelton water wheels, each of which consists of two, thirty-four and one-half-inch Pelton wheels, direct con-

nected on the same shaft and each of which is driven by two three-inch jets. Regulation is to be effected by an improved type of the Pelton differential cut-off governor.

Direct coupled to each of these water wheels is a Stanley 500 horse-power, inductor type, two-phase generator, each of which is guaranteed under contract to have a commercial efficiency of 94.6 per cent., and an electrical efficiency of 98 per cent. The foundations of the power house are of the solid bed-rock granite, upon which the generator foundations are placed. These foundations consist of eighteen inches of concrete upon the bed rock through which were run thirteen three-quarter-inch iron bolts that had previously been sulphur-cemented into holes that had been drilled into the granite to a depth of eighteen inches. Bolted by this means to the concrete are three timbers dressed down to eight by ten inches that have previously been tarred and wrapped with two layers of P. & B. roofing paper and finally imbedded in cement. The holding-down bolts for the bed plates of the generators are lag screws, which in turn are sulphur-cemented into the wood timbers, thereby attaining the highest possible insulation resistance to earth. The generators will be provided with two Crocker-Wheeler multipolar exciters, each having a rating of five kilowatts. These are to be belt-driven by independent Pelton wheels, and either will be of ample capacity to excite both generators.

No step-up transformers are to be used, as the generators will deliver two-phase current to the line at 5500 volts. The pole line is very close to eight miles in length and carries eight No. 3 B. & S. bare copper wires on two cross-arms, each pole being gained for two additional cross-arms. Thirty-feet round peeled poles are used, and throughout the entire line a sixty-foot clearance has been cut for the pole line through the timber and brush. The line loss is to be approximately 5 per cent., and the plant will be operated at 16,000 alternations per minute. Triple petticoat top-grooved porcelain insulators, five inches across the bell and manufactured by F. M. Locke of Victor, New York, are being used throughout.

The machinery for the plant was transported by rail to Nevada City, Cal., which is a little less than five miles from the power house, and from the outset difficulties of an unusual character were encountered. The scene of operations is in the midst of that portion of California which was the center of hydraulic mining activity until the anti-debris agitation put a stop to that mode of mining. The roads are, or rather were at the time when the transportation of the machinery was commenced, in practically the same condition as existed during the early mining days. They were exceedingly bad thoroughfares laid out over the shortest routes, almost regardless of grades. Whole mountain sides had been washed away by the hydraulic miners, and the rush and anxiety attendant upon the search for the precious metal forestalled all attempts at road-building, with the result that the highways were impassable for heavy machinery. The wagon road, such as it was, did not reach within nearly two miles of the site of the power house, which compelled the building of a



FIGURES 3, 4 AND 5.—*The Site of the Dam and Diverting Flume, the Completed Dam and a portion of the Flume Line, respectively, of the Nevada County Electric Power Company.*

road over an exceedingly mountainous country, in addition to which the contractor found it necessary to partially reconstruct the old wagon road to the extent of clearing it of rocks and boulders, and widening it sufficiently to admit the passage of heavy machinery. This was drawn to the top of the slide by means of teams varying from six to twelve horses each, according to load. Each of the Stanley generators consists of six pieces weighing approximately five tons each, the heaviest piece being the inductor, which weighs 11,200 pounds, and which proved to be the most difficult piece to transport. A special truck was constructed for it, and despite the unusual precautions taken a break-down occurred (Figure 6), and although the blockade thus occurring could be cleared out within a day with the appliances at hand, the urgencies for preventing delay in transporting other machinery were so great that a new road was built around the break-down. The character of the country through which this road was constructed is clearly shown in the illustration and the growth of underbrush, cactus and small pine and scrub oak trees was so dense as to render road building a serious task. Many of the grades on this improvised highway were so steep as to necessitate lowering the trucks down by means of block and tackle, yet despite this the machinery reached its destination without having suffered the slightest injury.

The greatest obstacles to be surmouted were those encountered in lowering the machinery down the mountain side, shown in Figure 2, in which the power-house site appears upon the river bank. In this illustration photography fails to bring out much more than a suggestion of the steepness of the slide. Within a horizontal distance of probably one-half a mile the mountain rises to an elevation of about 1700 feet above the river level. The first 400-feet drop from the top may be reached by wagon road. Continuing downward, the next 400 feet is an angle of twenty-five degrees, and the next 600 feet is an angle of thirty-two degrees. Then follows about eighty feet of thirty-five degree declivity, and finally a further drop of about 220 feet is made to the power-house site at an angle of thirty-nine degrees, down which not only all machinery for the plant has been lowered, but upon which the pipe line has to be laid and securely anchored.

The means by which the machinery has been lowered down the slide are those familiarly applied in house moving, and which is termed "snubbing." Each piece of machinery is mounted singly upon a heavy log sled made in the most substantial manner, and secured thereto by means of chains, ropes or in such other manner as will prevent slipping. Generally three $1\frac{1}{2}$-inch manilla ropes are then secured to the sled and machinery, each such rope being wrapped several times around a tree trunk, and a man being stationed at each of the three trees to control the ropes. The load is then lowered gradually by slacking the ropes or "snubbing" them as in house moving.

Figures 6, 7 and 8.—*Illustrating some difficulties encountered in the installation of the Transmission Plant of the Nevada County Electric Power Company.*

The illustrations given convey a suggestion of the methods used in overcoming the barriers presented in

this interesting installation, and it is worthy of note that despite the many and unforeseen difficulties encountered the work of installation has progressed without mishap or delay, and the plaut will without doubt be in operation by December 10th.

The mechanical features of the work have been placed under the direction of Mr. T. J. Benny, and the entire electrical equipment has been erected for Mr. Martin through the electrical engineership of Mr. E. E. Stark, of the Stanley Electric Manufacturing Company, whose apparatus is being used throughout.

The plant now being erected constitutes the initial installation, and it will therefore be enlarged as necessary to meet future demands. Probably seventy-five per cent. of the capacity of the plaut will be absorbed in the delivery of power to the mining industries of the vicinity, and already sufficient business has been contracted for to more than defray all fixed charges.

Pneumatics.

AN ECONOMICAL AIR PLANT NOW BEING INSTALLED AT THE NORTH STAR MINE.

By Edward A. Rix, P. E.

The North Star Mining Company, of Grass Valley, Nevada County, California, has made a long stride ahead iu the direction of economical power service, by installing upon their property a very complete system for the transmission and use of compressed air.

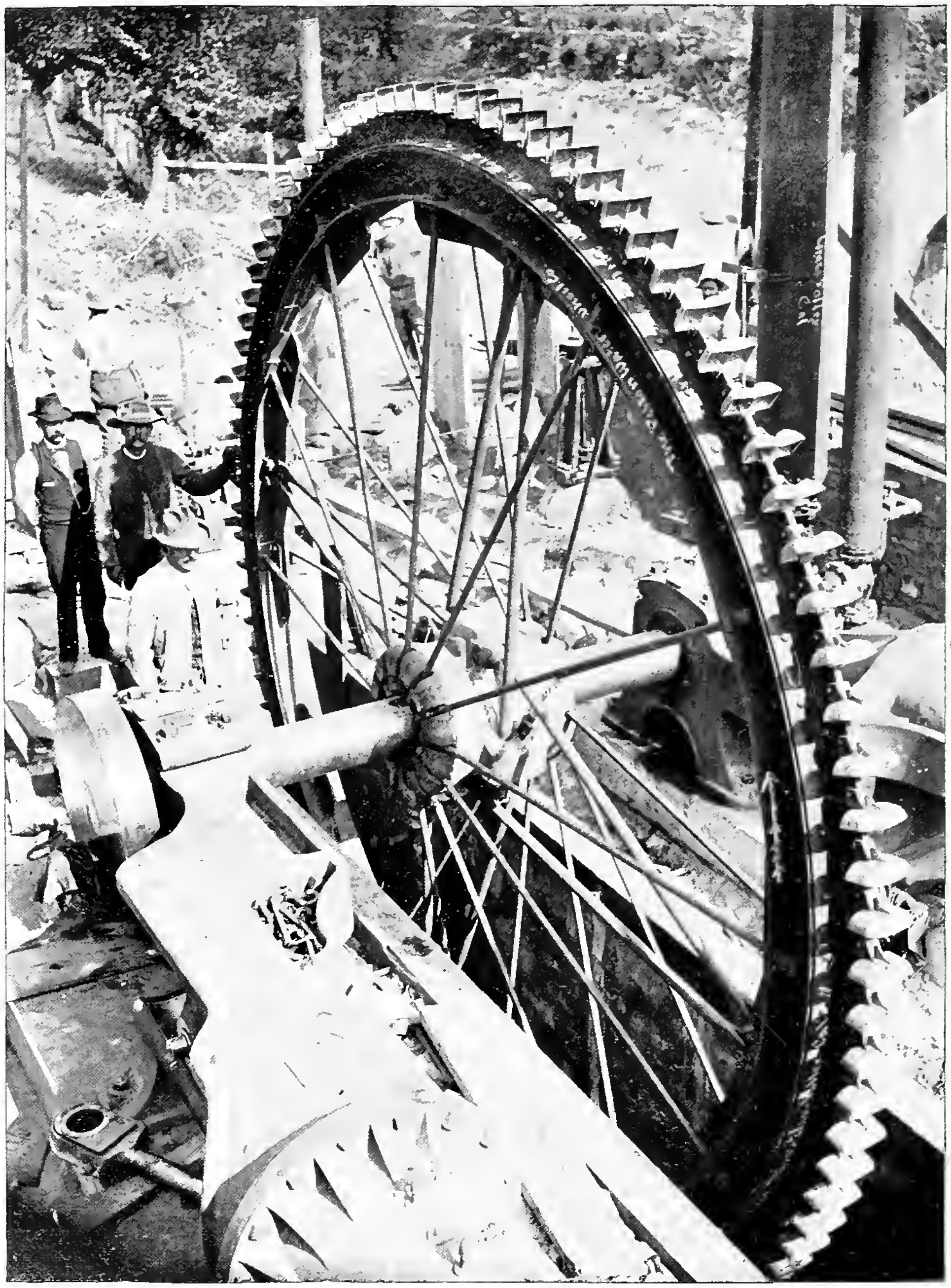


Figure 1.—*The North Star Air Transmission Plant. The largest tangential Water Wheel in the world, as it appeared before being housed in.*

It has been dawning upon the minds of power users that compressed air, which heretofore has been considered a luxury, can be bent to mine use quite economically and most conveniently. Much energy has been expended of late, also, by the advocates of compressed air, in disseminating information regarding the economy of air when it is used under proper conditions. Heretofore in California, with perhaps one exception, air has been used

cold in the engines or motors into which it has been introduced. Owing to the sudden and very considerable drop of temperature which occurs on the expansion of air in a motor cylinder, it is impossible to use it cold in engines of the expansion type, for it would take but a few moments to freeze up the lubricants and discontinue the operation of the machine. A gentle amount of heat, however, applied to the air before it is used in the motor, not only increases its volume to a marked extent — for instance, somewhat over forty per cent. upon heating to 350 degrees — but it supplies to the air a sufficient quantity of heat, so that when it is expanded in the motor cylinder, its exhaust temperature offers no inconvenience to proper working conditions. Air heated to this temperature can be expanded from its initial pressure down to the atmospheric pressure without any inconvenience whatever, and with most economic results.

speed of the machine is 440 feet, which, while not quite as economical as one somewhat lower, was dictated by the conditions under which the water-wheel operated.

The air enters the initial cylinder at the temperature of the power room, which is approximately 62 degrees, and is therein compressed to 25 pounds to the square inch gauge pressure. It leaves the cylinder at a temperature of 200°F., and passes through an inter-cooler of about 1000 running feet of one-inch copper tubes placed directly beneath the water wheel, and which receives from the wheel a continual shower of water at a temperature of about 58 degrees. This cools the air to such an extent that it is delivered to the high-pressure cylinders at a temperature of 60 degrees. In these cylinders the air is compressed to 90 pounds, and is delivered from the cylinders at a temperature of 204 degrees into six-inch mains which lead to the mine. Indicator cards taken

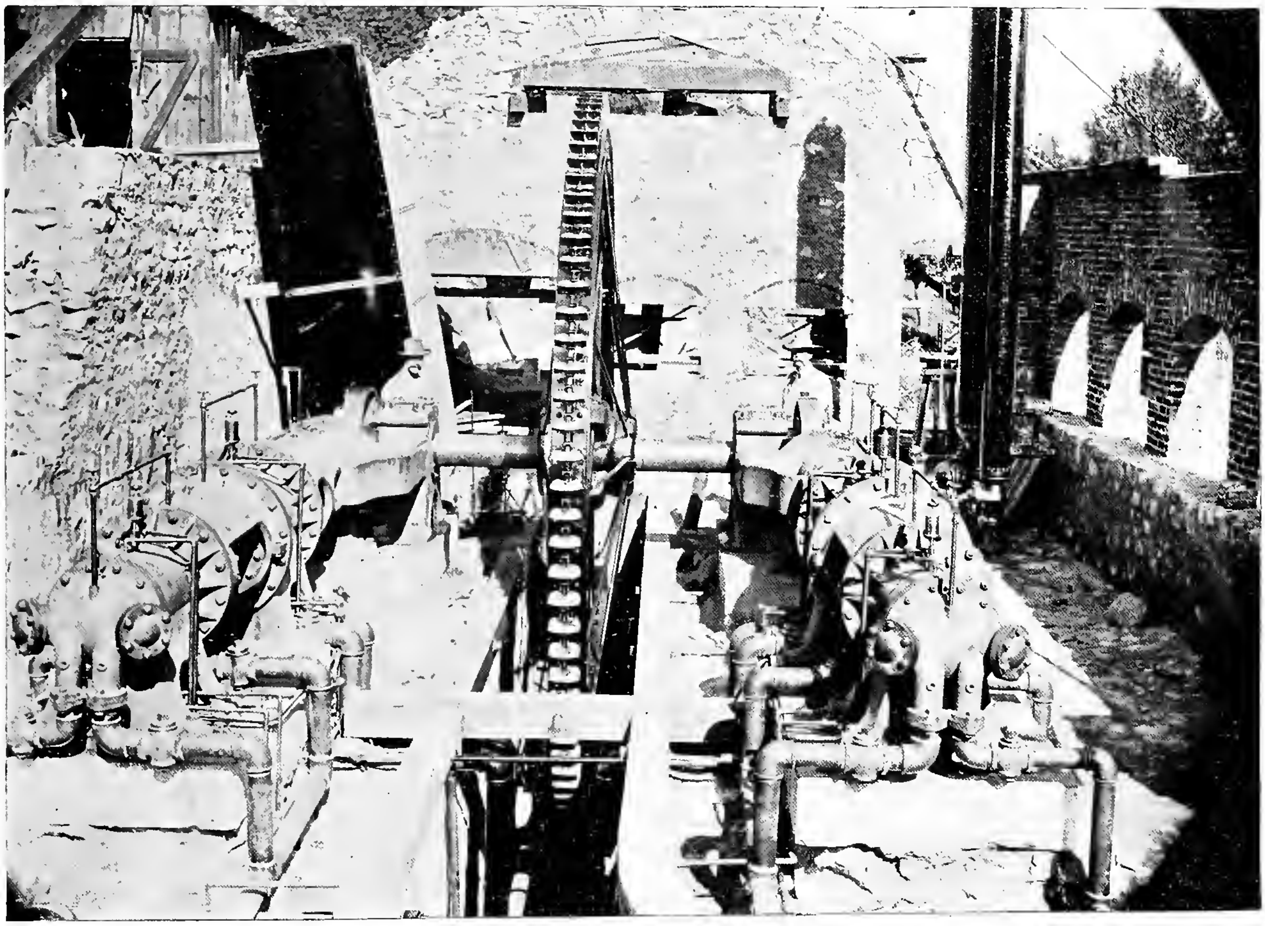


FIGURE 2.—*The North Star Air Transmission Plant. A general view of the Rix Duplex Air Compressors and Pelton Water Wheel, from a photograph taken during Installation.*

Realizing all this, after an extended investigation upon the subject, the North Star Mining Company, having a splendid water-power at its disposition, decided to install a very economical compressed air plant. A. De Wint Foote, M. Am. Soc. C. E., was placed in charge of the operations, and, after receiving bids from firms both in California and the East, the contract was placed with the Fulton Engineering and Ship-building Works, of San Francisco, for the compressed air plant, which concern placed the matter in the hands of the writer for execution. All the machinery was designed under his direction.

As shown by the half-tones accompanying this article, the compressors consist of duplex tandem compound machines. The initial cylinders are eighteen inches in diameter, and the high-pressure cylinders are ten inches in diameter by twenty-four inch stroke. The piston

from the cylinders show that the cylinders are doing equal work, and at 110 revolutions they work smoothly and perfectly.

Notwithstanding the fact that some builders claim that clearance has no detrimental effect upon the economy of their air compressors, in the Rix compressors the clearance is practically eliminated, being not to exceed 1-32d of an inch at each end of the stroke. The cards taken from these cylinders are perfectly square cornered.

The water-jacket system is quite unique, it being a duplex system — that is, there is an independent circulation for each end of the cylinder, the water passing longitudinally back and forth on the side of the cylinder and from the center in two independent streams, cooling the heads at the same time. The efficacy of this water jacket will be noted in the temperatures above given. The efficacy of the combined water jackets and inter-

cooler will be noted from the fact that in the single-stage machine, and at a pressure of 90 pounds, the final temperature of the air, if not cooled during compression, would be 459°F. In this machine the combined temperatures of delivery in the two cylinders is 404 degrees, the difference between these temperatures showing a very substantial gain in work, which otherwise would have to be lost.

In testing for volumetric efficiency, the receivers were carefully measured a number of times and found to contain 291 cubic feet. These were filled repeatedly, and the number of revolutions of the machine accurately counted each time. All of these experiments were conducted after the machine had been in operation for a sufficient length of time to reach its maximum temperature.

The barometer at the power house is 27.35 inches, corresponding to an elevation of about 2400 feet. This gives an atmospheric pressure of 13.32 pounds per square inch. At 90 pounds gauge pressure the ratio of compression would be 7.7, and the receiver containing 291 cubic feet represents 2240 cubic feet capacity of free air. The average of a great many experiments showed that the compressor took $102\frac{1}{2}$ revolutions to fill the receiver from 25 pounds, which is the pressure of the initial cylinder, to 90 pounds. At this pressure of 25 pounds gauge, there is 830 cubic feet of free air in the receiver. The difference between these two capacities, or 1410 cubic feet, would represent the amount of air which was forced into the receiver at the revolutions stated. Inasmuch as the temperature of the receiver is somewhat higher than the temperature of the inlet air, there should be a deduction made from this sum corresponding to that temperature of about 2%, making the corrected amount delivered to the receiver 1382 cubic feet.

The theoretical capacity of the compressor, deducting the piston rods, and at $102\frac{1}{2}$ revolutions, is 1429 cubic feet of free air per minute. The ratio between 1382 cubic feet, actually delivered, and 1429 cubic feet, theoretical capacity, is 96.6%, which represents the actual volumetric efficiency of the machine at the present writing. This, of course, will vary proportionately with the ratios of the absolute temperatures of the inlet air, depending upon the season of the year.

One peculiarity about the Rix compressor, as may be noted from the drawing, is the fact that the compressor is so arranged that any cylinder may be disconnected, or any end of any cylinder may be disconnected without interfering with the operation of the machine. This feature is very valuable in case of repairs or accident to the valves, any one of which may be removed and repaired, and replaced without stopping the machine.

To drive this compressor there has been placed upon the main shaft a Pelton water wheel, eighteen feet in diameter, which is believed to be the largest tangential water wheel ever made. This wheel is of peculiar construction, and was designed by Edward S. Cobb, M. E., of San Francisco. The head of water being 775 feet, and it being considered advisable to do away with all gearing, belting or ropes, it became quite a question to determine how to construct this wheel. In the first place, the piston speed of the compressor was placed as high as possible, 440 feet being considered about the limit that should be practically employed. This gave 110 revolutions for the compressor shaft. The most economical rim speed of the wheel, which is fifty per cent. of the spouting velocity, has placed the wheel at 18 feet diameter. Being operated at a peripheral speed of 6210 feet per minute, fears for its safety made the use of cast iron inadvisable, and even cast steel did not offer the necessary advantages. Mr. Cobb suggested the construction which is shown in the accompanying engravings, and the results have fully justified his calculations.

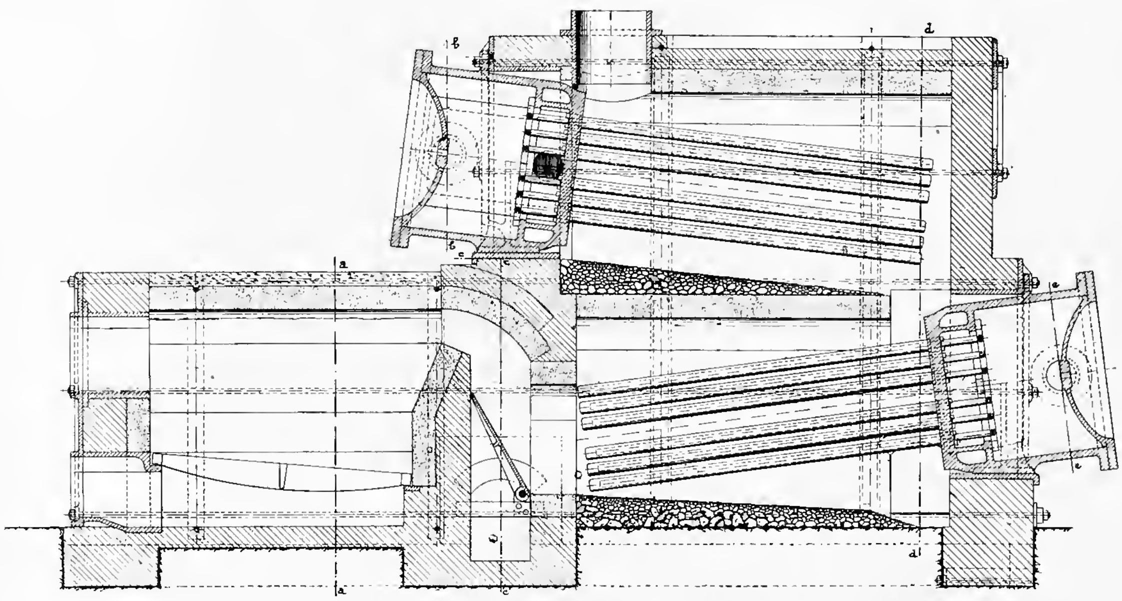


FIGURE 3.—*The North Star Air Transmission Plant. The Rix Compound Pneumatic Reheater.*

It will be noticed that there is a marked difference between the construction of this wheel and the ordinary bicycle wheel which it seems to suggest. In the bicycle wheel all spokes are in tension and are tangent to a circle concentric with the hub of the wheel, whereas in this wheel there are radial rods in tension to support the rim, and Mr. Cobb has introduced driving trusses to transmit torsional stress from rim to hub, all as shown in the outline view of wheel, Figure 4. The rim is of wrought iron, riveted up in convenient cross-sections, and the dimensions of the wheel are as follows:

Diameter over all	18	ft.
Width of face	8	in.
Diameter of shaft	10	"
Length of hub, bore	20	"
Length of hub over all	29	"
Center to center of spokes laterally at the hub	24	"
Center to center of truss rods at the hub	30	"
Diameter of radial spokes	$1\frac{1}{4}$	"
Diameter of truss rods	2	"
Weight of rim	6,800	lbs.
Weight of spokes	1,500	"
Weight of hub	2,800	"
Weight of ninety-six Pelton buckets	672	"
Total weight of wheel	11,772	lbs.

The buckets are of bronze, being eight inches wide, and the cover being two and one-half inches deep. They

add eight inches to the diameter of the wheel, and after being milled are riveted upon the outer rim. In actual practice the wheel is splendidly balanced and runs perfectly true and is an entirely satisfactory method of construction. Running at its standard speed with the connecting rods off the wrist pins and suddenly shutting the water off, it will continue to run fourteen and one-half minutes before it comes to rest, showing a correct balance. Water is supplied to the wheel through about 8000 feet of twenty-inch riveted steel pipe, built by the Risdon Iron and Locomotive Works.

The wheel is governed by automatic devices, which keep it at a standard speed and stop it and start it according as the air pressure increases or falls below the standard pressure. The compressed air, after leaving the compressors, is conducted to the mine and delivered to the reservoirs above mentioned, from which it is taken into the Rix pneumatic reheater, a cut of which is shown herewith. It is here heated to 350 degrees Fah., and delivered to the initial cylinders of a compound direct-acting pneumatic hoist. In this cylinder the air is cut off at one-half and exhausted back to the compound compartment of the reheater, where this air, which is about twenty-five pounds pressure, is again heated to 350 degrees. From here it is conducted to the compound cylinder of the pneumatic hoist and expanded to atmosphere, at a temperature of about 160 degrees, the exhaust flume connecting with the dry room for the men.

The air is also conducted from the reheater to operate a Dow compound sinking pump, having a capacity of 600 gallons per minute, and still further down the mine for operating rock drills.

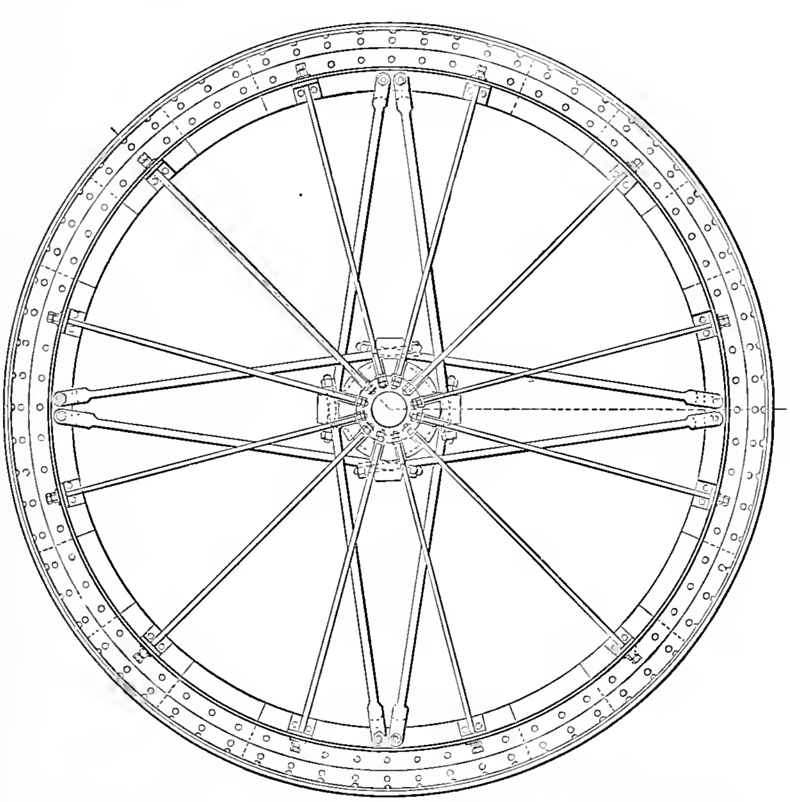


Figure 4.—*Outline Plan of the Pelton Water Wheel in use in the Air Transmission of the North Star Mine.*

The pneumatic hoist is not yet in operation, and will be the subject of a further description when it is completed. If the anticipations of the designers of this plant are realized, the pneumatic hoist will develop in its cylinders the indicated horse-power of the compressors at least, and possibly will exceed it. The entire economy of the system should exceed eighty per cent.

This plant is receiving a great deal of attention from the mine owners of the Pacific Coast who anticipate putting in power plants, and its successful operation will determine the installment of others of a similar kind. Nothing is being spared to make the North Star installation complete in every respect.

We would suggest that there is necessity for a change in the sub-title of our western contemporary, the "Pacific Electrician," which states that it is "the only electrical paper on the Pacific Coast." This is not accurate. Messrs. Perrine and Low's new paper, the "Journal of Electricity," is published in San Francisco and shows great signs of promise.—The Electrical Review, New York.

Hydraulics.

"CENTRIFUGAL PUMPS" AND ~~PNEUMATIC~~ Hydraulic PRINCIPLES.

By L. M. Hoskins.

All who are interested in hydraulic machinery will read the essay published by Mr. John Richards on the construction and operation of centrifugal pumps with profit, for the experience of Mr. Richards, as a mechanical engineer and designer of pumping machinery, enables him to give valuable information regarding the development and present condition of centrifugal pump construction, especially on the Pacific Coast. The work embraces two main points—a discussion of constructive features, and a historical sketch. An appendix contains brief discussions, by the author and others, of some interesting questions of theory and practice. No systematic discussion is given of the scientific principles underlying the design and operation of centrifugal pumps. In fact, it is stated at the outset that these pumps "defy the mathematician," and it is evidently the author's belief that theory is of little value in their design.

Under "constructive features" the following are the main points discussed: Size of impeller; form and dimensions of pump chambers; forms of impeller and of vanes; balancing of impeller against water pressure and against the weight of shafting and machinery; the question of double or single inlets; and the special requirements for dredging pumps. The question of attainable efficiencies is also touched upon, and the opinion expressed that for large pumps and for heads not exceeding twenty feet an efficiency of seventy per cent. should be realized.

After an instructive historical review of the centrifugal pump, it is pointed out, regarding its modern history, that the most noteworthy development is in the direction of high lifts. It is stated that these pumps have been successfully operated in California against heads as great as 160 feet. This fact is in striking contrast with the statements frequently found in works on hydraulics to the effect that the usefulness of centrifugal pumps is confined to low lifts.

It is not easy to understand why the theory of centrifugal pumps should present greater difficulties than that of reaction turbines. The hydraulic principles involved are identical in two cases, although, as our author says, the description of a centrifugal pump as an "inverted turbine" is quite inaccurate. It may be of interest to give here a brief statement of the main principles involved, and a comparison of the two classes of machines.

By "reaction" turbine is here meant one which operates with passages completely filled with water. The

term does not accurately describe the operation of such a turbine, but no better name seems to have been suggested. The main conditions to be observed for the efficient working of such a motor are: (1) The water should enter the wheel without shock; (2) the flow through the wheel should take place without sudden change of velocity; and (3) the absolute velocity of discharge from the wheel should be as small as possible. To satisfy these conditions, the direction of wheel-vanes at entrance and exit points, and the speed of rotation, must be properly adjusted to each other. As a general rule, it may be said that water should enter the wheel with an absolute velocity directed nearly tangentially forward, and should leave the wheel with a relative velocity directed nearly tangentially backward. This relative velocity, compounded with the tangential velocity of the wheel at the point of outflow, should give as small a resultant as possible.

During the gradual deflection of the water in the wheel passages, energy is transmitted from the water to the wheel. What percentage of the energy lost by the water is thus utilized, and what percentage is carried off by the outflowing water, in the case of any given turbine working with a given head of water, depend upon the speed of rotation. If the speed is gradually increased, beginning at zero, the percentage of energy given to the wheel increases up to a certain maximum value, and then decreases; and for some values of the speed of rotation it becomes zero. If the speed is still further increased, the energy transferred to the wheel becomes negative, or, in other words, *the water receives energy from the wheel.* Now, if in this latter case the design of the wheel is such that the energy lost by dissipation into heat by friction, impact, etc., is not too great, the wheel will operate as a pump, aiding the flow. Thus, a centrifugal pump is not an "inverted" turbine, but rather a turbine running at too high a speed to operate as a motor.

In estimating the flow through a turbine and the energy taken from (or given to) the water for a given head and velocity of motion, the only principles needed are "Bernoulli's Theorem," giving the relation between velocity of flow, pressure and height, at all points of a stream in a condition of steady flow in fixed passages, and the analogous theorem for flow through rotating passages. These theorems need not be given here, but it is to be remarked that they apply equally whether the turbine operates as a pump or as a motor, and the problems of design should be as readily solvable in one case as in the other.

It is a well-known principle that, for a given turbine motor of the reaction type, the speed for highest efficiency varies as the square root of the head. Further, if the head changes, and the velocity of rotation changes as the square root of the head, the velocity of flow through the wheel (and therefore the quantity of water discharged) will vary in the same ratio as the speed of rotation. This is, perhaps, the most serious disadvantage of reaction motors. If the design is made for a certain fall and discharge, the wheel cannot yield its highest efficiency for a different fall, unless the supply of water changes correspondingly, and it cannot give its highest efficiency for a changed supply of water, unless the fall is correspondingly changed.

The same principle would seem to hold for turbine pumps. If a pump is designed so as to give a high efficiency when working at its best speed against a given head, any change in the head will cause a decrease of efficiency, unless the speed of rotation is changed in the ratio of the square root of the head, and if this is done, the discharge will vary in the same ratio. Thus, suppose a pump working against a head of 36 feet has its highest efficiency when making 300 revolutions per minute, if the head is decreased to 25 feet, the speed for best efficiency should decrease to 250 revolutions per minute, and the discharge would be only five-sixths as great as before. The given pump could not, therefore, raise as much water against a head of 25 feet as against 36 feet without a decreased efficiency. It is doubtful whether this principle is clearly understood by manufacturers.

The influence of the form of the impellus vanes upon the efficiency is one of the questions discussed in Mr. Richards' essay. The author seems to regard this as of minor importance, especially with low lifts. Theory indicates as desirable a curve of such form as to gradually deflect the water until its direction of flow near the outlet of the wheel becomes nearly tangential and opposite to the motion of the wheel. The object of this is to make the *absolute* velocity of exit as small as possible. This absolute velocity necessarily has a forward tangential component of considerable magnitude because of the rotation of the wheel, and this should be neutralized as completely as possible. The form of vanes is, doubtless, of less practical importance with low lifts than with high, because a much lower wheel velocity is needed to give the required presssure in the discharge chamber. Efficiency is often made a less important consideration than capacity.

The existence of a high velocity of outflow from the impeller passages would be of little detriment to the efficiency if it were possible to produce a sufficiently gradual transition from this velocity to that in the discharge pipe. This may doubtless be partly accomplished by the gradual enlargement of the passage leading from the impeller chamber to the discharge chamber. This feature is used in the design of Schabaver, of which an account is given in the appendix to Mr. Richards' book, and is said by the author to have been also devised by Mr. G. W. Price, of San Francisco. According to the description given, the method of Schabaver is to make the discharge chamber "a narrow orifice extending around the whole circumference of the casing," and gradually widening outwards, "so that the water arrives without shock in a spiral collector surrounding the pump and leading into the discharge pipe." This is identical in principal with Boyden's "diffuser," used for a like purpose with turbine motors. Francis, in his experiments with the Fremont turbine, found that the use of a diffuser gave an increase of 3 per cent. in the efficiency. (Lowell, Hydraulic Experiments, page 5.) Experiments seem to be wanting to show the value of this construction in the case of pumps.

It is probable that the efficiency suffers much greater diminution by frictional losses at high speeds than at low. This matter of frictional losses and other practical objections to extreme high speeds would seem to be the limititing condition for the working of pumps against high heads, since high rotational velocity is necessary to produce high pressure in the discharge chamber. It is doubtful whether this difficulty can be completely overcome except by compounding.

The plan of compounding two or more pumps in series has been employed with apparently complete success. From a theoretical stand-point, the compound pump seems to furnish a complete solution of the problem of efficient working against high heads. If two exactly similar pumps are used, each yielding a certain efficiency when working alone at a given velocity against a certain head, and if the discharge pipe of one is made the inlet pipe of the other, the two ought to work against a double head with undiminished efficiency; the best speed of rotation and quantity of discharge being the same as for each pump working alone against the original head.

The frictional loss of efficiency should be the same for the compound pump as for the single one working at the same speed and discharging the same quantity of water. Each pump, in fact, does the same quantity of work, whether acting alone or compounded with the other; the sole difference in the conditions of the two being that the pressure in every part of one is greater by a constant amount than that in the corresponding part of the other. There is no apparent reason why, by compounding any required number of pumps in the same way, water cannot be raised to great heights as efficiently as to moderate ones. The question of high lifts thus becomes one of economy of construction and maintenance rather than one of possible successful working. So far as first cost is concerned, Mr. Richards expresses the opinion that it is much less for a compound pump, such as he illustrates on page 59, than for piston pumps, to do the same work.

The matter of the balancing of impellers is of much interest, both theoretical and practical. The "hydraulic step," by which the pressure of water in rapid rotation is made to balance the weight of shafting or other loads, was invented by Professor F. G. Hesse, and is the subject of Bulletin No. 2 of the Department of Mechanical Engineering of the University of California. Space is wanting for a description of this interesting device or an account of its theory.

On the whole, the impression given by a careful reading of Mr. Richards' book is that designers in America, and especially on the Pacific Coast, have attained a high degree of success in the adaptation of turbine pumps to a variety of conditions. It seems probable, however, that still further advance may be made by the intelligent application of hydraulic principles.

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RESONANCE IN BOILER EXPLOSIONS.

By Lieut. W. Stuart-Smith, U. S. N.

Occasionally a boiler explodes under circumstances which make it exceedingly difficult to determine the cause. The evidence of those in whose charge the boiler is entrusted is to the effect that the steam pressure was not above the normal and water was carried at the proper height, so there could be no danger of explosion from overheated plates. An examination of the debris shows no evidence of overheating the metal of the shell, traces, etc., show good section, with no evidence of serious erosion, and a test shows the metal to be of good quality. With good metal of proper section and boiler well proportioned, it is manifest that rupture can only occur through excess of pressure, and the report of the examiners is that without doubt the fireman neglected his duty and allowed the pressure to reach a point which was beyond the strength of the metal to withstand.

In cases where the evidence in favor of the fireman proved to be so strong that no possible doubt could be expressed regarding the fact that the pressure was not excessive, and examination showed no defect in design or material, the necessity for an explanation brought forth theories to account for instantaneous development of enormous pressures. According to one of these, the water over the furnace crowns might exist in a spheroidal state—that is, be held out of contact with the plate by a layer of steam—in consequence of which the plate became highly heated, and the spheroidal state being broken, the water was brought into contact with the hot plate and flashed into steam, thus producing a sudden enormous pressure with a resulting explosion. The propounders of this theory did not realize that, owing to the large amount of heat rendered latent in evaporating a small quantity of water, the excess of heat in the plate would not be sufficient to evaporate any considerable quantity, even if such a spheroidal state, with consequent heating, would be possible with the rough plates and other conditions existing in a boiler.

Another theory that was much propounded was that water was decomposed by some electric action, andthat the resulting oxygen and hydrogen, existing as a highly explosive compound in the proportions necessary for formation of water, accumulating in considerable quantity, was in some manner ignited, with resulting enormous increase of pressure and explosion of boiler. Apparently no consideration was taken of the fact that even if oxygen and hydrogen were thus formed they would pass off with the steam, hydrogen especially, on account of its low specific gravity, being very quick to do so.

At present such theories are scoffed at, and the verdict is that the pressure was allowed to become too great—a faulty steam gauge or other cause preventing a careful fireman from being aware of the fact. Such verdicts, however, are sometimes rendered solely because the examiners realize that excessive pressure must be the cause, and, rejecting what they know are absurd notions, they find themselves confronted with the necessity of assigning a valid reason.

Still, mysterious explosions sometimes occur, and the writer believes they may be caused by a sudden increase of pressure, and offers the following explanation, which, while it may, to some, seem as absurd as the theories quoted, is founded on strictly scientific principles and represents a by no means impossible condition.

Resonance has long been studied in relation to sound, but it is only within recent times that the very important place it may occupy in cases where force is transmitted by means of vibrations in elastic media has been realized. In cases where steam and other vapors and gases are used as the media for the transmission of force, this transmission is not accomplished by means of vibrations in the elastic medium, but the medium itself is strained, and being transmitted in mass to the point where it is desired to have work performed, it is placed in conditions favorable to the release of the tension. During this recovery from the strained state, work is performed equal in amount to the energy which disappeared in producing the strained condition. It is only in the case of those substances, such as gases and vapors, which are elastic and mobile in the highest degree, and which can have their volumes varied through wide limits without altering this state, that practical use, for purpose of performing continuous work, can be made tendency to recover from a state of strain. Other substances, such as ivory, glass, etc., are highly elastic, but the limits through which they can be strained are too narrow to permit of their use in performing continuous work.

Vapors and gases, possessing the property of elasticity in such high degree, are not only capable of receiving enormous static strain, and in this state, being transferred from place to place, but they are capable of being strained by an impulse received at one point, and of recovering from this state of strain by transmitting it to neighboring portions of the mass, thereby setting up vibrations which gradually die out, owing to the want of perfect elasticity. This fact being recognized, it is possible to offer a theory which the writer believes furnishes a correct explanation of many mysterious boiler explosions, and incidentally accounts for some peculiar looking indicator diagrams which are usually set down as water in the cylinder, inertia of the moving parts of the indicator, etc.

The distributing valve of the engine being closed, steam fills boiler, steam pipe and valve chest, and has no

motion as a mass. The valve opens and permits steam to enter the cylinder, thereby giving motion to the mass of steam in the pipe, the velocity attained being, say, 100 feet to the second at the moment of cut-off. When cut-off occurs this motion is arrested at the steam chest owing to the rigidity of the metal, but along the body of the pipe no such impediment exists, and owing to its inertia the steam continues its forward movement, compressing the portion before it until the resistance to compression finally brings the mass to rest. When this occurs the steam at and near the engine will have a density considerably in excess of that near the boiler, and there will be the equivalent of an impulse producing strain at one point of an elastic medium. The result will be that the recovery from the strained condition will send a wave toward the other end of the pipe and the boiler, which wave will tend to travel back and forth through the pipe with continually decreasing amplitude. The same thing will occur at the following and all other admissions of steam to the cylinder, so that, in addition to the periodically interrupted forward motion of the steam as a mass, there will be a series of waves continually traveling backward and forward through the pipe. If the time of propagation of a wave from the engine to the far end of the pipe and return differs materially from the time elapsing between cut-offs in the engine, the mass of steam will be filled with a series of vibrations moving in both directions, and differing in phase to such an extent that there will be so much interference as practically to eliminate all vibrations, and instruments will make no record of them. If, however, the conditions are such that the first wave formed travels forward and returns just as the wave formed by the second cutting off is ready to start forward the two will add themselves together and a single wave of increased amplitude but same wave length will go forward, with result that, in addition to the steady strain on the pipe due to the pressure of the steam, it will be subjected to waves of strain which pass along it. This occurring for several consecutive revolutions of the engine, the amplitude of the wave will, by resonance, be raised to a very large figure, and a very great strain be brought to bear on the pipe. Such a wave passing into the boiler and then rebounding will subject it to a *sudden* increase of pressure, much in excess of that due to the steam, and will have its effect increased owing to the fact that it will be applied as a live load. A sudden enormous increase of pressure in a boiler may be thus explained on a strictly scientific principle.

The energy due to the forward movement of the steam at one cutting off may be readily calculated. Suppose there is a 10-inch steam pipe 100 feet long, steam pressure 125 pounds. At this pressure there are 3.549 cubic feet of steam per pound, or the total quantity of steam in the above pipe wlll be 15.36 pounds. With steam, at moment of cutting off moving 100 feet per second, the energy of the moving mass of steam will be 2385 foot pounds, which is the force which will compress the steam preparatory to the production of the first wave. In a very brief period, if the conditions are right for the production of resonance, this energy will be many times multiplied.

Such a condition of affairs is certainly possible, though it will occur only at rare intervals, and it is sufficient to account for some mysterious explosions. It is impossito guard against, owing to the variety of conditions which are influential in producing it. In order that the maximum effect may be produced it is necessary that the primary vibration period of the steam in the pipe should correspond with the times of cutting off steam in the cylinder, and there is usually sufficient variation in the speed of the engine to perhaps greatly promote interference; moreover, the vibration period of the steam is itself continually changing, as it depends upon the elasticity of the steam, which is a continually varying quantity, since it is affected by every variation in the pressure and by every variation in the amount of entrained moisture. It might happen that a steam plant would operate for many years without the proper condition for maximum resonance occurring; then the proper relation of steam pressure, entrained moisture and engine speed might occur, and in a few moments a disastrous explosion would take place, with absolutely nothing to show the reason why. Steam pipes as well as boilers will explode from this cause.

With regard to the engine indicator, it occasionally happens that an instrument which is in excellent condition and usually takes fine cards, is applied to an engine, and the cards show an admission line which rises far above the steam line, and even far above full boiler pressure. Sometimes this line falls back at once to steam line, and again it may enclose a small area before reaching this line. The expert thinks there is water in the cylinder, and, finding this is not the case, blames the indicator. There may in reality be water in the cylinder in some cases, and certainly indicators are sometimes to blame for such additions to the card, but it will be occasionally noted that some particular engine has a habit of showing such cards when the steam is dry and the indicator in good order. At times, even, there is a hump in the steam line between admission and cut-off. If our theory that resonance may cause, in the steam pipe, waves of considerable amplitude is correct, we have a possible explanation of some of these card peculiarities. If, as the valve was opening, or after it opened and before steam was cut off, a wave reached the steam chest it would record itself locally on the card as an increased pressure which would be called "water" if made on the admission line, and a curiosity if made on the steam line. Of course it could produce no effect after steam was cut off.

Where an engine persists in showing this peculiarity it seems probable that the conditions as to length of steam pipe, pressure carried, revolutions per minute, etc., are right for producing partial resonance, either with the main wave or one of the harmonics, and it would be well to so alter the condition as to break up this resonance in order to avert danger of explosion due to an accidental adjustment of conditions whereby more perfect resonance might occur.

BERKELEY, Cal., *Nov 25, 1895.*

MULES FOR PASSENGERS.

The march of improvement has deprived the little city of Ontario, Cal., of the greatest novelty that that town afforded. Before the trolley made its advent, a solitary car used to wend its way, pulled up a slight incline between a beautiful avenue of trees several miles in length, the motive power being a pair of patient mules. When the end of the road was reached, a curious sort of flat car, looking not unlike an old-fashioned trundle bed, was pulled from under the passenger car and hooked behind. The two mules then mounted their flat car, the driver took his place at the brakes, and the trip commenced down the grade to the town, and of all who have taken this romantic ride, none have enjoyed it more than the mules themselves.

The popularity of a technical publication can best be determined by the demand for it, and in this connection it is interesting to note that it has been necessary to reprint two numbers of the "Journal of Electricity," namely, the August and September issues, to supply orders for back numbers.

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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EDITORIAL.

THE FAR WEST RECOGNIZED.

The recent appointment of a local secretary of the American Institute of Electrical Engineers for the Pacific Coast shows an important advance in the policy of the Institute as well as an encouraging sign of the character of the electrical engineering on the Pacific Coast. Heretofore the Institute has been charged, with more or less justice, with being a close corporation, run in the interests of certain members residing about the city of New York. The first succeessful broadening of the Institute policy was found in the establishment of local meetings in Chicago; but local meetings have been viewed with suspicion by certain of the New York members, and little encouragement has been given to the informal meetings of members at places where the membership was too small to warrant local meetings on the Institute plan. The informal meetings held in San Francisco during the past winter were of undoubted personal benefit to all members who attended, and they will, we hope, be the cause of bringing forth a greater mumber of papers written by those residing on the Pacific Coast. It is gratifying now to find that at last the efforts made toward impressing the necessity for greater recognition of the Pacific Coast members have been appreciated by the Council, and there is but little doubt that the confidence shown by the appointment of a local secretary will be amply justified.

COMPETITION IN THE TELEGRAPH.

While undoubtedly the recent decision of the Supreme Court, denying the right of the Pacific railroads to make an exclusive lease of their right of way to any one telegraph company, will have an important bearing on the telegraph service to points between San Francisco and Chicago, and possibly upon the general telegraph business of the Pacific Coast, it must not be supposed that the entire question of the competing telegraph line is settled by this decision of the courts. The courts may without a doubt compel the revocation of such exclusive leases, but it is hardly possible that they will undermine the present good will existing between the telegraph companies and the railroad. This good will of itself is in general of a greater value to the telegraph company than the simple question of right of way, since it is the custom of the railroad company, which acts in harmony with any particular telegraph company, to furnish a system of inspection to the telegraph company, through the medium of their track walkers, and to allow special facilities on their trains for the transportation of repair supplies and linemen. Where such courtesies are not extended, the simple right of way is of comparatively little value, indeed, of almost no more value than the right of way through the open country by the side of the railroad track, which at any time might have been secured. These complicated conditions are not often considered by the general public, in rejoicing over a court decision similar to that we have chronicled, whereas, to the practical engineer, the points now covered are of more importance than those upon which the courts may render their decisions.

ELECTRIC VS. "COAL CAR" TRANSMISSION.

It is with interest that we note that an effort will be made to transmit electrical energy from the mines of Corral Hollow to Stockton, San Jose and other cities, and even with greater interest do we hear that the power derived is to be applied to the operation of an electric railroad thirty-two miles in length, extending from Livermore to Oakland. Proposals similar to this have been made in England, and for a transmission of energy from the Pennsylvania coal fields to certain of the neighboring Eastern cities, although the application of power to railroading is a proposal which adds a new element, opening new possibilities to the plan. The possible financial economy of the scheme depends upon whether it would be cheaper to transmit the energy of the coal over an electrical line than it would be to carry the coal itself by railway or steamer to the point of consumption. In the one case an excess of electrica energy must be developed, which is utilized in the transmission of the electricity itself; in the second case, a proportion of the coal itself must be burned to effect the transportation. In carrying the coal bodily, account must be taken of the maintenance of the railway necessary for its transportation, whereas in the transmission of power by the means of electricity is had a cheaper line to maintain, although, perhaps, a greater amount of the total energy of the coal must be utilized in the transmission. The calculations made by English engineers have indicated that the electrical transmission of energy of the coal is probably the cheapest manner in which a definite amount of coal can be used, and when we consider the fact that freight rates are much lower throughout England than in California, it seems that we may be able to predict a very considerable financial saving to the users of the electrically transmitted power, as well as a profitable undertaking to the owners and promoters of the electrical enterprise.

LIGHT HAULAGE BY MEANS OF ELECTRIC MOTORS.

The question of light haulage by the means of electric motors has attracted much attention since the early attempt of the late Prof. Fleming Jenkin to establish in England an automatic overhead hauling system which he named Telepherage. Little success attended the various efforts to establish telepherage lines on account of the fact that the overhead line construction to support motors sufficiently heavy for the necessary tractive effect was too expensive when compared with tram lines laid upon the ground, although the construction necessary simply to carry the loads to be moved might in some cases be cheaper than tram lines. The Boynton bicycle railway is one that possibly reduces the cost of construction when compared with the other systems of elevated railways, but it can hardly be possible that any such rigid overhead construction would be as economical as a surface road.

These difficulties have been met by Mr. Richard Lamb in his system now being installed along the banks of the Erie Canal, and already in successful operation for the haulage of logs in the Dismal Swamp of Virginia. The system consists of a pair of standing ropes suspended from a stout pole line construction, the upper cable carrying the weight of the motor and its load, while the lower cable is proportioned simply to afford tractive effect by means of passing it several times around a sheave attached to the locomotive motor. The current is carried by the bearing rope, and returned to ground through the traction rope. Undoubtedly, less power will be used by this system than that which is necessary in the commoner systems of cableways with running traction ropes, and a wide application might be predicted for such a system in the hauling of light loads over moderate distances.

The important proposition of this haulage system, however, is one that looks towards the re-establishment of artificial inland waterways that have so largely been superseded by steam roads. No doubt the Lamb system is a system well adapted to boat towage, but its success as a means of haulage does not by any means establish the efficiency of artificial inland waterways. In the case of the Erie Canal, fifty-one millions of dollars have already been expended upon its construction, and it is stated at the present time that nine millions further must be spent before the canal can be operated at a maximum efficiency. Mr. Frank W. Hawley, who has the contract for applying electric haulage to this canal, anticipates that its introduction will warrant the use of about three thousand boats carrying two hundred and sixty tons each on the canal, which would mean that as many as ten boats to the mile would be towed. These boats, as recently built, have cost fifty-five hundred dollars each, and when we consider that at least fifteen central stations, having an aggregate capacity of not less than thirty thousand horse-power will be required to furnish the power, it is at once seen that the interest on the cost of the investment necessary to apply the system to the Erie Canal in an efficient manner would bring the cost of transportation of goods from Buffalo to Albany up to a figure which would be little if any below the charges now made by the steam roads, and it is hard to see how the simple applicability of any such haulage system by the means of electrical power would warrant the great outlay necessary for building and maintaining an expensive system of artificial inland waterways such as are proposed from time to time by the daily press in its campaign against the alleged extortionate freight rates.

AN INACCURATE ESTIMATE OF POWER TRANSMISSION.

It is surprising that a journal as carefully edited as the Engineering Magazine should print an article so full of inaccuracies as that of Alton D. Adams on the "Limits of Electrical Power Transmission," which purports to show that the annual fixed charges on an electrical transmission line twenty-five miles long will amount to $22.83 per horse-power hour, as against a cost of $25.00 per hour for steam power, coal costing between $2 and $3 per ton. If the statements in this paper could be established, there certainly could be no possible economical distribution of power from a water-fall or other source greater than fifteen to twenty miles; but when we analyze the items of cost given by Mr. Adams, which pretend to be the lowest possible figures, we find that he makes the statement that 4794 horse-power of electrical machinery at $20 per horse power are required in the transmission and delivery of 1000 horse-power, the total amount of power being composed of 1520 horse-power in generators, 1000 horse-power in motors and 2397 horse-power in transformers, omitting altogether the consideration of the fact that the Stanley Electric Company transmits power at 10,000 volts without the intervention of transformers. We are astonished to see that Mr. Adams rates such generators and transformers as high as $20 per horse-power, whereas during the last year generating machinery has been sold on the coast as low as $11.00 per horse-power in cases where not more than 500 horse-power were purchased, and the figures that he gives are higher than the price for 600-light dynamos in the city of Boston four years ago. Besides this misstatement, Mr. Adams has included in his estimate for wire the amount necessary to transmit 1000 horse-power 100 miles, in place of 25 miles, which is the assumed condition of his problem. Making these corrections in his figures, we find that his total cost of installation is to be divided by at least two, and in place of almost $23 per hour for transmission cost, not more than $10 or $12 should be allowed.

Transmissions approximating the distances he attempts to prove impossible have, unfortunately for Mr. Adams's figures, already proved themselves to be economical, and such inaccurate statements will do little to advance rational transmissions or to guard against those which are irrational.

Passing Comment.

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

The question of the rating and behavior of fuse wires has at last been adequately treated in a paper read by Prof. W. M. Stein before the American Institute of Electrical Engineers. The minimum currents required to fuse such wires has been accurately ascertained in the experiments of Preece. The experiments of Harrington show the great currents they will carry on short circuits, and although it has heretofore been understood that time is a factor in the current necessary for fusion, the particular value of this time factor has not been clearly shown experimentally. These experiments have probably established the most accurate methods of fuse testing, and we fortunately are now able to predict the action of fuse wires under various currents, applied either rapidly or slowly.

In the Electrical Engineer for October 16th a leading article calls attention to the practical installation of electric launches as pleasure craft on a large park lake, and to those who have had the pleasure of riding on these launches at the Chicago Fair it is not surprising that such installations should be found remunerative.

While it may be possible that the weight of the cells is a disadvantage in tramway work, and that the constant jarring will disintegrate the plates, there is no doubt but that they are acting under ideal conditions when applied to boats, and there can hardly be a system conceived more directly applicable to their needs than in electric roads which are continually striving to increase their earnings by the establishment of parks and excursion parties. The current for charging is at hand wherever cars run, and the rates of fare are much higher than can be charged for any equivalent amount of land haulage.

One of the most important papers before the Montreal convention of the American Street Railway Association was read by N. W. L. Brown on the preservation of ties and poles by means of creosoting. Iron poles, though strong, have not given the life that was at first hoped from their use. Such materials as redwood and cedar are too weak to stand the great strains applied to trolley suspenders, while the life of the stronger woods is found to be very limited.

Creosoting has obtained an unmerited position of disfavor on account of the imperfect manner in which this operation has often been performed, but Mr. Brown's tests prove that where the work is thoroughly done the life both of poles and ties are so far increased that the operation is one effecting a great economy when all the items of annual expense are included. This subject is well worthy of consideration on the Pacific Coast particularly, as the long, dry summer effectually seasons the timber and greatly reduces the cost of creosoting as compared with localities where wet timber must be treated.

The question of transfers on our street railway systems has been so throughly discussed in the daily papers from the standpoint of the passenger, that one would almost imagine there were no disadvantages connected with the transfers to the railway management. Should such disadvantages consist simply of the decreased service for a single fare from individual passengers, the argument against their extensive use might be invalid, but to any one who holds this opinion there would be great enlightenment on reading the article by J. A. Cahoon, on the "Use and Abuse of Transfers," in the Electrical World of October 18th, where it is shown that the principal loss to the railway companies comes not so much from their legitimate use by the passengers as from their illegitimate use by the conductors and motormen, largely increasing the stealing from the company. We venture to assert that rarely does a street railway company wish to curtail its traffic or to inconvenience its passengers, but until some system of transfers be adopted which will avoid their being exchanged from one conductor to another, much sympathy must be felt for any railway company desiring to curtail their use.

The exact measurement of voltage, current and resistance by means of potentiometers is treated in an article in the Electrical World of October 12th, by W. M. Stein, of Chicago, in which he calls attention to the inaccuracies often creeping into the application of the potentiometer method of measuring current. This method is one that is so easily applied with a simple sensitive galvanometer, a standard cell and a couple of high resistances, that it admits the exact measurement of large currents for testing purposes where a high-reading galvanometer or ammeter are not at hand, and the method of using it should be thoroughly understood by all engineers. An imperfect understanding, however, will easily lead to exceedingly inaccurate results, and the principles involved, while simple, have been misstated even to the extent of omitting the instructions necessary for connecting to eliminate the internal resistance of the standard cell and galvanometer.

The method consists simply in passing the current to be measured through a large German silver resistance, the value of which is known; at the ends of this resistance a series of high resistances are connected in parallel with it, and the terminals of the standard cell connected through the galvanometer in such a sense that the e. m. f. of the standard cell will be opposed to the fall of potential from one end to the other of the high resistance. When the connection of the standard cell to the high resistance is so adjusted that there is no deflection of the galvanometer, then the e. m. f. between the terminals of the standard resistance is obtained by the relation of the total resistance between its terminals to the resistance of that portion which equals the e. m. f. of the standard cell.

Following the recent meeting of the Street Railway Association in Montreal, considerable amount of space has been devoted by all of the electrical papers to the subject of the most efficient brake for trolley tramroads. The speeds employed in these roads have continually increased from six or eight miles an hour to fifteen or twenty, and, even in some cases where considerable distances are to be covered in suburban districts, speeds exceeding thirty miles an hour are employed. When we consider the great momentum of a car weighing from fifteen to twenty tons running at such speeds, we can at once realize not only the difficulty but the importance of an efficient brake system. For ordinary stops the efficiency of the brake does not become of so great importance as it does when an emergency stop is to be made. Cable roads are all provided with an emergency brake, consisting of a solid shoe which may be pressed against the track hard enough to lift the car free from its wheels should extreme rapidity in braking be necessary, but where such brakes have been applied to cars not held to the track, as is the case with the cable car, by means of the grip attached to the cable, this emergency brake has been found likely to derail the car, and, in consequence, such a method may not be employed. The two methods of emergency braking, which seem to have been met with the greatest favor, are the air brake and the Sperry electric brake. Up to the present time, the disadvantage

of the electric brake has been found to be due to the fact that it requires the car motor to be rapidly transformed into a generator, and, where the commutator contact on the motor is dirty by long service, it will generally refuse to build up its own field and generate the current, while the air brake requires considerable extra weight for the brake mechanism, and depends upon a reservoir which may fail when the car is running slowly through a crowded district requiring frequent stops. It certainly seems that the electric brake is capable of giving much more efficiency than can be obtained by the means of an air-brake, but until one or the other of these systems has attained a greater perfection than is apparent up to the present, the running of high speed trolley cars must be considered as attended with a very appreciable amount of danger to foot passengers crossing the tracks.

The discussion which has followed Professor Forbes' publication of his view concerning the engineering contest in the Niagara transmission, has led to some adverse criticism of Lord Kelvin's preference for direct current power transmission, and many eminent authorities, led, perhaps, by Professor S. P. Thompson, have laid particular stress upon the adaptability of alternate currents to many various uses. It is stated by these advocates of alternate current transmission that no other system can be so easily manipulated and adapted to the many purposes of arc and incandescent lighting, long distance transmission of power, the transformation into any required voltage, and the regulation by the means of controllers, requiring but a small expenditure of energy; but these engineers have not taken the pains to call general attention to the fact, that, though an alternating current may be easily adapted to such uses, it is not by any means true that the same alternating current is applicable in every case. In order to install incandescent lamps with the maximum economy as regards first cost of lines and transformers, it is necessary that a current with a high number of alternations be employed, for efficient arc lamps to operate without annoying, noisy vibrations, a periodicity much less must be used, while the proper regulation of such lamps by impedence coils demands a current of high periodicity. Again, motors and rotary transformers are only to be considered as acting under ideal conditions whenever the periodicity is so low that the current approaches almost a pair of continuous currents in its character. The only engineer who has appreciated this problem sufficiently to attack its solution seems to have been Professor Rowland, to whom a late patent has been granted for a device capable of changing an alternating current of any number of phases or periodicity into one of any other number of phases, or other periodicity, varying the transformation of an alternating current all the way from a continuous current to a high periodicity multiphase current. As this invention has been explained up to the present time, it presents formidable complications, which seem to leave for the alternating current but small maintenance advantages above the continuous current system, which it seeks to replace, and to be very little if any better than the continuous current transmission operating motor transformers.

The great powers, which are available in coal mines and water-falls, are already being looked at with some suspicion by competent engineers, on account of their remoteness from the manufacturing centers. Although there is no doubt that the limit of twenty-five miles, which has been set by a writer in the Engineering Magazine, which we notice elsewhere, is entirely too small a limit, still the investigations of our best engineers, who have attempted the solution of long distance problems, show that the limit of economical transmission with machinery operating at 15,000 volts is not far from fifty miles where alternating current machinery is employed; that direct current machinery will extend this limit is difficult to predict, though it seems that many cases might be found in which the greater adaptability of direct current machinery to the many uses for which it might be employed would prove to be a greater financial success until the difficulties of manipulating alternating currents, as above indicated, have been more perfectly solved.

Literature.

ELECTRICAL ENGINEERING, LEAFLETS, in three grades, Elementary, Intermediate and Advanced, by Prof. EDWIN J. HOUSTON, Ph. D., and A. E. KENNELLY, F. R. A. S., 8-vo, cloth, 300 pp. Price for each course, $3.00. The Electrical Engineer, New York, 1895.

It is gratifying to notice that the desire for information concerning the principles of electrical science has become sufficient to warrant the production of many courses of instruction from the pens of the most distinguished and competent engineers. Among the many books published during the past few years with the aim of supplying this need, we have noticed none by authors more competent of speaking to practical men than these three volumes, which have been divided into grades, as best suited to the needs—first, of artisans with little or no knowledge of mathematics; secondly, to the understanding of those having an elementary knowledge of mathematics, and thirdly, to the needs of students pursuing a more advanced course under the direction of a competent instructor.

The value of the study to the student in any such course depends upon the exactness and thoroughness with which the elementary principles are explained rather than upon the newness of the apparatus described, and can never in any published book be entirely in harmony with the most recent practice, on account of the ever-changing nature of recent applications. Of these three sets of leaflets, the greatest importance is attached to the elementary grade, for the reason that so little which is accurate has been written that has been adapted to the understanding of electrical artisans and others with little or no previous knowledge of the subject.

It is a question whether the advanced course does not include more than can thoroughly be taught to university students in Electrical Engineering without an extension which would divide the subject matter of these leaflets into two or three separate courses of instruction; though for mechanical engineers and others whose time is largely devoted to collateral branches, an elementary knowledge of the principles and application of electricity is here given most clearly and concisely.

Turning our attention now to the leaflets of the Elementary grade, and viewing them from the standpoint of those for whom they are designed, we should expect to find sufficient information therein to enable a man who has completed their perusal to understand the conversations and the simpler descriptive writing of the ordinary electrical engineer, and we should demand that the information should be exact, as far as the student is carried. It is with much pleasure that we find here that this aim has been mainly well carried out, and that withal the writing is so phrased as to be easily understandable. But we must presume that there is a good amount of intelligence and earnestness possessed by any man who would take the trouble to follow this course voluntarily. If this is so, it seems to us to be a pity that our authors have begun by confusing the terms "energy" and "work," in the first chapter, though each term is correctly used in

the body of the book. Again, we notice that the explation of the term "potential" has been altogether omitted, though lts elementary explanation can certainly be made simple, even though a complete understanding of "potential" may be difficult, and this omission is the more unfortunate since it is hardly possible for any one to understand what is said by engineers without its use. Besides this, the term "potential," when understood, explains more perfectly the character of the volt as a unit, and brings it more nearly to the comprehension of those who are accustomed to use the common mechanical units in the measurement of concrete quantities. Exactly why such a unit as the watt is omitted from the definitions, when the more complicated magnetic units are introduced, is hard to explain, especially as the authors use the unit by name in the body of their own text.

In the discussion of magnetism one would criticise the introduction of the term "magnetic flux," and its confusion with the lines of direction in a magnetic field; these terms are altogether distinct, and it seems that a great confusion may be produced in the minds of practical men which will be hard to eradicate.

On the whole, however, these points which have been criticised are not of great importance when we observe that the general tenor of the book is exact, and that its careful perusal will give a good understanding of the principles of the science, and will lay a firm foundation for further study. If the perusal of this first volume will lead any man to continue his studies into the second or intermediate grade of leaflets, the omissions we have noticed are largely supplied, and a course through the two books is the best and most practical that we have yet seen.

In no one of the three volumes is the true theory of the glass line insulator explained, and the province of the petticoat is not mentioned. Many constructors are prone to consider only the insulating property of the glass without reference to surface conduction, which leads too often to insulators being installed upside down as well as to the use of porcelain knobs out of doors, which would point to the importance of a more thorough discussion of the action of line insulators in such a course of instruction.

Much has been written at many times, especially in books treating primarily of physics, which refers so imperfectly to theories of electrical action that the elementary student is confused in his more advanced studies, and it is with great gratification that we notice in none of these leaflets matter which must be unlearned before an advance can be made. The three courses are well adapted to the needs of those for whom they are designed, and, though each is complete in itself, yet, as already stated, a great amount of benefit may be derived in considering the first two sets as a continued course, and in pursuing the third under the direction of an instructor.

The Electrical Transmission of Energy, by Arthur Vaughan Abbott, C. E., New York, D. Van Nostrand Company; pp. 586, 8-vo. Price, $4.50.

We have already published a preliminary notice of this manual of electric line construction, written by Mr. Abbott, the chief engineer of the Chicago Telegraph Company, and under whose supervision some of the best transmission lines in the United States have been constructed. It is not often that an engineer so well qualified has the inclination, and finds the time for giving the results of his mature deliberations to the general public through the medium of a book, but when it is our good fortune to obtain such a work, we find with the liveliest sense of satisfaction that the instructions given are all of an authoritative character, and that they will repay the closest perusal.

Naturally the section of this book on the construction of aerial lines, occupying three chapters, is the most valuable and complete, since these circuits are the ones most carefully studied by the telephone engineer. The lines of the American Bell Telephone Company throughout the country are undoubtedly the best constructed of any system of transmission lines, and, although Mr. Abbott gives us complete information concerning the general subject of line guying, and the construction of poles for carrying great loads, and for standing the excessive strains applied to anchor poles, we search in vain for the consideration which has led the telephone company to adopt their system of construction, which includes extra braces for cross arms, and a complicated system of guying in the direction of the line itself, in addition to the very complete system of side guys employed. The section devoted to the construction of electric railway circuits is more complete, including as it does the return circuit with an extensive discussion of the rail bonding question and electrolysis. Throughout the book there are a great number of different tables, some of which have been calculated by the author from well-established data, while others represent experimental results obtained by various investigators, and while there is no doubt of the usefulness of these tables and their general reliability, it seems unfortunate that in so few cases are the authorities for the tables given, which leaves the reader in consequent doubt as to whether the tables are due to the author's own investigations, or to those of others working in the same line. This is particularly unfortunate when we find that in some cases doubtful constants have been used, such as the conductivities in tables Nos. 3 and 7, where undoubtedly the published reports of manufacturing companies have been accepted as accurate without sufficient justification.

In his discussion of wire gauge he states that the Brown and Sharp gauge has been accepted as the standard for this country, but at the same time his tables for iron wire refer to the Imperial Standard gauge, which, so far as we are aware, has not been used to any extent by either our manufacturers or constructors. Some of the tables are also presented without accurate data or formula for their verification or extension, which is in many cases decidedly important, as, for instance, the table on page 453, purporting to give the areas given, covered by multiple wire systems, conforms neither to the indefinite formula which is given, from which it is supposed to have been computed, nor to any one of the well-established methods of obtaining the results given. Again, we find in table No. 55 the statements of the relative amounts of conducting material required in various conducting systems where continuous and multiphase alternating systems are employed, but no method is given by which the table may be verified, or by which the engineer can obtain for himself the size of conductors necessary to carry a definite current on the multiphase systems. Where curves and tables of cost are furnished, we notice that they refer more particularly to European practice, and, in consequence, the data given is of comparatively little value to American engineers, especially as no general method is indicated whereby the tables may be corrected in order to conform with our practice.

The same criticism that the book conforms more nearly to English practice than that which is in vogue in this country may be applied to the chapter on underground lines. An explanation of this may be, perhaps, found in the statement made in the preface of the book that the object aimed at is to make the statements throughout correspond more nearly to the future direction of practice than to a historical exposition of what has been done, but where so important a matter as the construc-

tion of underground conduits is to be undertaken, the engineer would hardly be justified in following the lines laid down as typifying European practice in the Crompton, Calender-Weber and other such systems, without the aid of a more definite expression of opinion and the results of experience than are given in this book, especially since the descriptions seem to have been taken from the publication called "Practical Electrical Engineering," rather than described from personal observation.

Two long chapters are devoted to a description of instruments, and to an exposition of the practical methods of electrical measurement, while the only reason that can be discerned for their insertion is that the methods explained conform more nearly to engineering practice than to those of the laboratory; and, although there can be no doubt but that there is a need for such treatment of this subject, it is to be very much questioned whether the exposition occurs properly in this book, since the presence of these chapters must have added to the cost of publication, and the matter published is less than is has been closely followed without any marked extensions of the methods and results there given, except in the case where the treatment of the calculation for the most economical conductor in any given transmission is furnished. While following closely the lines laid down by the English author, he has succeeded in giving an intelligible exposition of the subject, which was decidedly lacking in the English treatise. The methods explained for the calculations of mains and feed wires in any system follow closely those explained in the work above mentioned, and it seems surprising that Mr. Abbott has not distinguished between circuits when lights are all on or all off at one time, and circuits on which the lights are altogether independent, especially since the distinction between these cases has been carefully made by Carl Hering in his book, the "Wiring Computer." One is compelled to feel on reading this book that while undoubtedly an authority on certain subjects, Mr. Abbott has presented to us a great deal of undigested matter, and has limited his discussion of the subjects with which he is thoroughly conversant on account of lack of space.

Handling a Heavy Cable.

required by the engineer in all of his every-day measurements. It seems to us that it would have been much better if this section had been reserved for a more complete treatment in a separate treatise, especially as the subject matter given by Abbott has already been presented by Park Benjamin in his book on the Voltaic cell.

We have already alluded to the lack of information necessary to calculate alternate current lines, and this lack is more apparent when we find that a chapter has been devoted to the expression of the theory of alternate currents following closely the lines of Bedell and Crehore, but not advancing in any particular way beyond the theoretical elements laid down by those authors. The same matter might have been explained much more intelligently had the method of Steinmetz's Graphical Analysis been followed, which would have allowed its extension to practical calculations. The section devoted to the calculation of lines for both series and parallel distribution is the most complete that has been given in any American book, but the method of the author in the work already noted, "Practical Electrical Engineering," As we have already said, the subject of aerial lines has been thoroughly and well treated so far as the treatment goes, and that the subject of electric railroad circuits has been well covered, and that, although the careful collection of matter contained in this book is an exceedingly valuable thing to all engineers, we feel disposed to express disappointment that one who is so competent an authority has not given a fuller expression of opinion on those subjects covered by his experience.

THE ELECTROLYSIS OF ORES.

The electrolytic separation of metals from their ores is accomplished by first reducing the crude ore chemically to salts capable of being electrolyzed. Different salts of the same metal, treated by different methods, yield to electrolysis with different degrees of facility, and produce the metal with varying degrees of purity, and in variable quantity with the same current. On the nature of the preliminary process, therefore, depends the success or failure of the results. Among the various ores reduced in this manner are zinc, lead, copper, silver, gold, aluminum, sodium and magnesium.

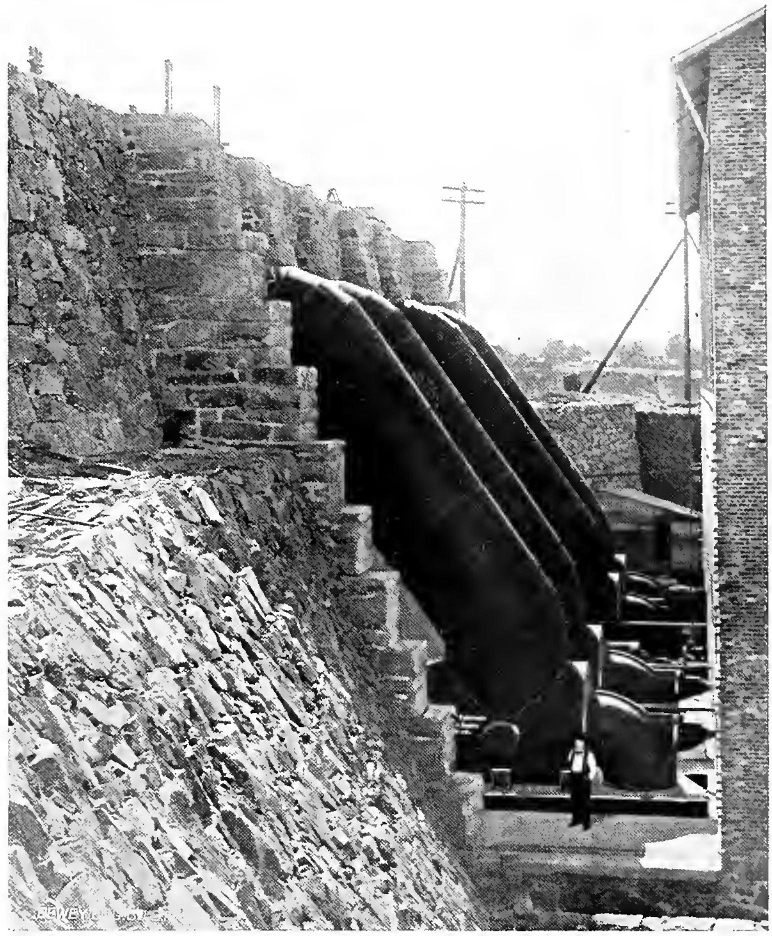
SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY.

The sub-station building of the Sacramento Electric Power and Light Company, corner of Sixth and H streets, Sacramento, which was only partially completed in September last at the time of the Electric Carnival, is now finished. As previously stated, the building is of fire-proof construction, and is of practically three stories, the basement being used for storage purposes, the first floor containing the three-phase synchronous motors and the street railway generators and arc-lighting dynamos, together with suites of offices, while the fourth floor contains the step-down transformer vaults and the testing rooms and supply rooms and other accommodations usual to central stations. On November 1st the city service rendered from the sub-station consisted approximately of 1500 incandescent lamps, about 100 commercial arc lights, and 650 horse-power for street railway uses. The company has also secured the city lighting contract, which will call for an additional 100 arc lamps on December 1st. Three or four hundred horse-power in motor service is also being delivered.

The finishing of the sub-station and the remaining two penstocks and water-wheels at the Folsom power-house practically marked the completion of the entire "Transmission Plant No. 1," and both of these features are illustrated herewith as supplemental to the article describing the plant presented in the September number of The Journal of Electricity.

The fact is also announced that the company has placed on the market its one and one-half million dollars in bonds authorized two years ago by the stockholders, and secured by a deed of trust to the California Safe Deposit and Trust Company. These bonds are in denominations of $1000 each, and bear 6 per cent. interest. Though issued in November, 1893, the managers of the company deemed it advisable to withhold the bonds from sale until the entire plant was completed, and could demonstrate its ability to earn profits, and none have ever been sold. As, however, the plant is now in successful operation, and the earnings have proved sufficient to pay all the operating expenses and bond interest and still leave a handsome margin of profit to the stockholders, application has been made to the San Francisco Stock and Bond Exchange to have the bonds listed, and, after the usual examination by the Executive Committee of the Exchange, the application was granted, and the bonds were on Nov. 20th offered for sale for the first time at $104.

The statement of the officers of the company shows the assets to be as follows:



FIGURES 1 AND 2.—*The Sacramento Electric Power and Light Company's Penstocks at the Folsom Power House, and the Sacramento Sub-station, respectively.*

Hydraulic works at Folsom (cash outlay)	$ 524,837.41	
Convict labor performed by the State for certain rights, viz: 700,000 working days at $1 per day	700,000.00	
Sacramento street railway system	610,650.00	
Toboggan railway at East Park, Sacramento	3,946.00	
Transmission plant at Folsom, and transmission line to Sacramento, and buildings and lands	496,289.49	
Power and distributing station at Sacramento	73,284.40	
Arc and incandescent light distribution system at Sacramento	25,000.00	
Total security for bonds	$2,434,007.30	
With no indebtedness other than the bond issue of	$1,500,000.00	
when the same shall have been realized upon.		
The gross annual income of the company amounts to	$212,962.36	
Deducting—		
Operating expenses and maintenance		$97,697.11
Interest on $1,500,000 bonds		90,000.00
	187,697.11	
Leaves an available surplus to the stockholders over all expenses and fixed charges	$ 25,265.25	

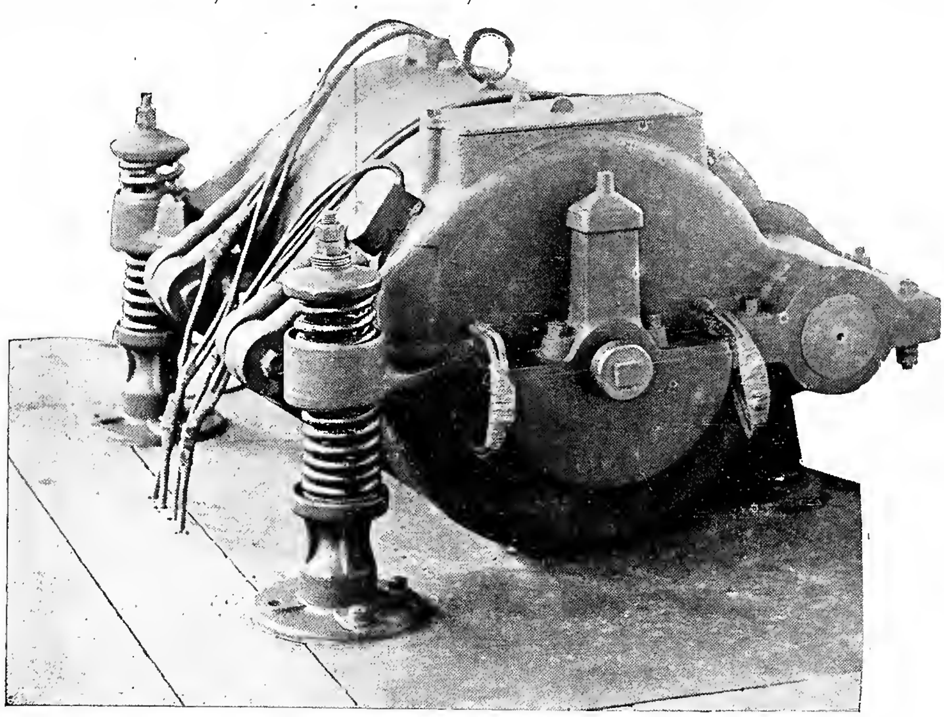
The capacity of the present generating plant at Folsom is 4000 horse-power, the transmission yielding an efficiency in Sacramento of 3000 horse-power, of which only 950 horse-power are being now used in producing the income of the company as above shown.

Contracts for additional power and light are now being made, and when the entire present generating capacity of the company's "Transmission Plant No. 1" is used, the net profits to the stockholder, after the payments of all charges, including bond interest, sinking fund and depreciation, will be upwards of $125,000 per annum, leaving out of the question, at present, future extensions of the generating plant at Folsom, which can be effected without any further expenditures on dam, headworks or canal.

PERSONALS.

Mr. S. Morgan Smith of York, Pa., the builder of the well-known McCormick Turbine, is visiting San Francisco.

Mr. C. D. Crandall, manager of the Western Electric Co., of Chicago, who is making a business tour throughout the Pacific Coast, is at the Palace Hotel, San Francisco.



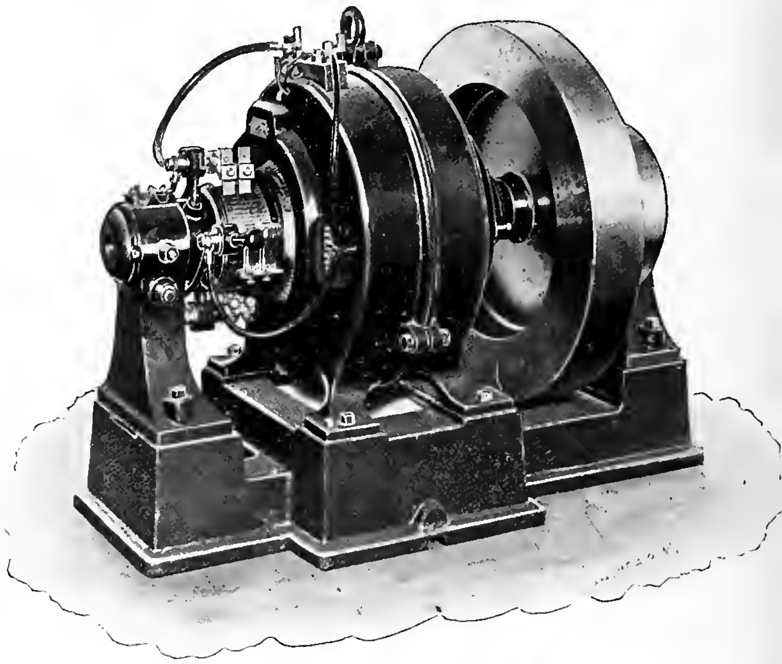
Reversible Mill Motor.

Dr. Thos. Addison, manager of the Pacific Coast office of the General Electric Company, has returned to San Francisco after an eastern business trip of several weeks duration.

The Trade.

SPECIAL REVERSIBLE MILL MOTORS.

The Card Electric Company, of Mansfield, Ohio, has recently brought out a special piece of apparatus termed a "mill motor," which is illustrated herewith, and which



Lundell Dynamos for Gas Engine Service.

is designed for handling heavy machinery in rolling mills, foundries and other places where a strong, simple and serviceable machine is imperative. As the illustration shows, this motor is completely enclosed, and can be used with safety in places where the open type of motor would soon be damaged from dust or occasional wetting.

Particular attention is called to the method of mounting. The front of the motor is supported on a cast-iron stand, rigidly fastened to the bed plate of the machine or other foundation, with trunnions on each side of the upper part taking through suite bearings on the motor case, forming a pivot for the motor to swing on. The rear part of the motor is supported on springs at each side, with springs above, held in compression by bolts through the pedestals, which support them, and which are also fastened to the bed plate. The object of this arrangement is to provide a flexible support for the motor, and a cushion for the gearing when heavy loads are thrown on the motor or the direction of rotation is suddenly reversed. In practice it has been found to work admirably, and, in addition to saving the gears, gives the motor a noticeable advantage in starting heavy loads at slow speed. Where the conditions are such that the spring suspension is not advisable, brackets are provided on the motor for bolting to the bed plate or foundation, rigidly.

The "reversible mill motor" when used with a suit-

able controller and current regulator makes a very desirable outfit for operating cranes, turn-bridges, hoists, bending rolls and other kinds of machinery which require various speeds in either direction. The motors are made in 20, 25, 30, 35 and 40 horse-power sizes, and are handled by the Sterling Electric Supply Company, Pacific Coast agents, San Francisco.

TIE PLATES ON ELECTRIC RAILWAYS.

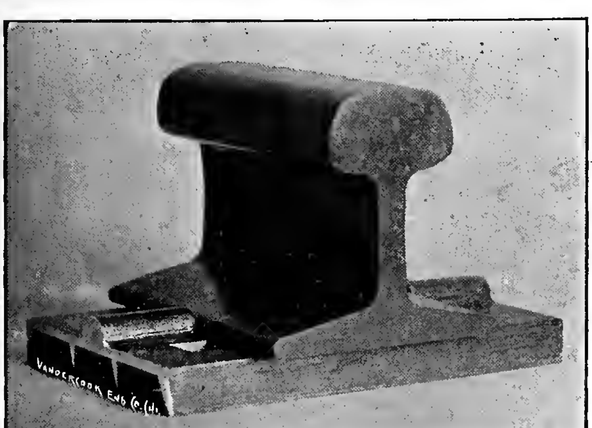
The street railway manager whose ties on country divisions are cut by rail flanges or weakened by frequent spiking, and who has found no satisfaction or adequate prevention of these and similar troubles, will be pleased to learn of the remarkable success being achieved with the Servis Tie-plate on electric lines. These simple appliances, which are used in numberless quantities on steam roads, have only recently been introduced for service on electric lines, but sufficient experience has already been had to demonstrate that with these tie plates, even under the heaviest traffic, the full life of the tie is secured, viz.: cedar, twelve years and upward; black and red cypress, fifteen years and upward; redwood, twenty years and upward. Even in the busy yards of steam roads, under constant and heaviest traffic, ties have their period of usefulness extended from two to eight years and upward, according to the quality of the timber.

As shown in the accompanying illustration, the Servis Tie-plate simply consists of a plate of cast iron, ribbed on one side, and varying in width from $3\frac{3}{4}$ inches to 6 inches. The plates are placed upon the tie with their ribs running parallel with the grain of the wood, and the flanges are driven into the tie when first applied, but after short service the fibre of the tie is compressed, its upper surface is forced down to the plane of the surface of the tie, and a perfect union of the plate and tie thus occurs. Marked economy, not only in the life of the tie, but in preventing spreading of rails or widening of gauge, in breaking ties and rails, and in breaking wheels, occurs, in addition to which the tie plate even tends to hold broken rails securely in place under moving trains.

Interesting literature concerning "Proofs of Servis" may be obtained from C. B. Kaufman & Co., 525 Mission street, San Francisco, Pacific coast agents for the Q. & C. Co. of Chicago.

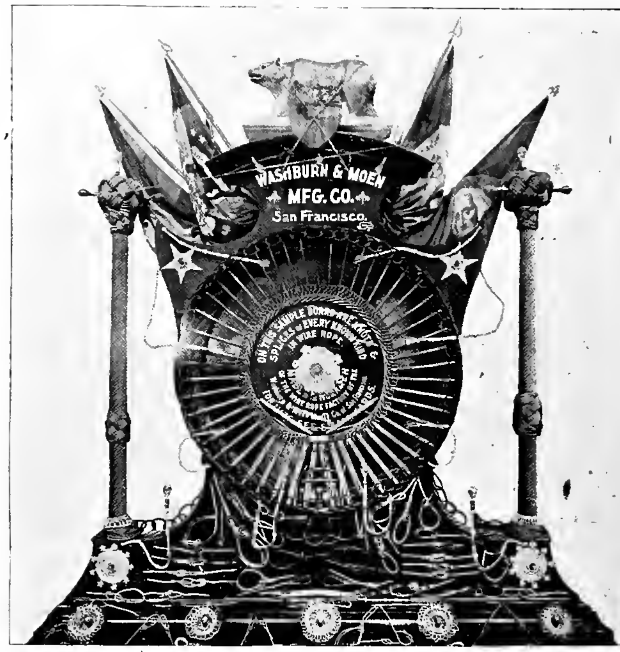
NEW WESTINGHOUSE OFFICE.

The San Francisco office of the Westinghouse Electric and Manfacturing Company is moving from the sixth



Tie Plates on Electric Railways.

floor of the Mills Building to the large and commodious suite of offices on the southeast corner of the ground floor of the same building, which will constitute the general offices of the company, and, in addition, has rented the basement of the building, to be used as warerooms. Many car-loads of electrical appliances of every descrip-



Some Products of the San Francisco Works of the Washburn & Moen Mfg. Co.

tion are being stored there, and hereafter the company will be able to furnish electric lighting, railway or transmission apparatus of almost every description, together with the usual central station supplies, without delay from its San Francisco office on the shortest notice.

HANDLING A HEAVY CABLE.

One of the first products of the San Francisco Works of the Washburn & Moen Manufacturing Company is the heavy cable manufactured for the Market Street Railway Company, and which is illustrated on page 122. This cable is 31,000 feet in length, is of $1\frac{1}{8}$ inches in diameter, weighs, including reel and truck, 130,000 pounds, and, as shown, required fifty-six truck horses to haul it. Another almost equally heavy cable, 30,000 feet in length, has recently been shipped to the Front Street Cable Railway Company of Seattle, Wash.

LUNDELL DYNAMOS FOR GAS ENGINE SERVICE.

Herewith is illustrated a modification of the well-known Lundell generator as constructed for service in isolated lighting when the motive power is furnished by a gas engine. Great improvements have been made in the last few years in gas engines, but up to this date no gas engine above 5-horse power has been available, it is said, that could be relied upon to operate at uniform speed. In order to provide for absolutely uniform electro-motive force, or, in other words, uniform incandescence of electric lamps in such a plant, the Interior Conduit and Insulator Co. has built a special generator which carries, in addition to the belt pulley, a fly wheel of heavy rim weight. In this fly wheel is stored up sufficient energy to compensate for the slight inherent irregularities in the speed of the gas engine. It will be observed that extra care has been taken in furnishing substantial pedestals, heavy shaft, and modern self-aligning and self-oiling bearings. The efficiency of the dynamos is from 86 per cent. for the small machines to 95 per cent. for the largest machines.

The Day Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

Thus far the trolley wire, languidly drooping earthward, has exercised a nice discretion, killing only its natural enemy, the horse. But there are many people on earth, and even a trolley wire may be indiscreet.—San Francisco Examiner.

The evidence that trees have been killed by electricity has been furnished by the fact that in numberless instances the trees through which electric light wires pass died in an hour during a storm, while those standing a few feet from the wires were uninjured. These results will raise the question as to the liability of electric light companies for the damage caused by the killing of shade trees.—San Mateo (Cal.) Leader.

The great possibilities for electrical power under the Southern California Mountain Water Company's system is not generally known by the people at large. Recent estimates show that, in the 2000 feet fall of 500 inches of Pine Creek above Barrett dam, 1600 horse power can be developed, and that, in the 1600 foot fall of 1500 inches from Cottonwood Creek, 4300 horse-power can be developed, while between Barrett dam and the city, 2200 horse-power can be developed.—San Diego (Cal.) Union.

Electricity is the coming power for manufacturing, transportation and lighting purposes, and the problem is how and where to secure it best and cheapest. San Bernardino will soon want power for electric cars and for motive power in shops and manufactories, and it is well to look after the supply, or, large as it is, it may be too late to secure it advantageously when wanted. There seems an almost inexhaustible power for the production of electricity in our mountain streams, but it is being secured and utilized, and when a large supply is needed for San Bernardino, it may be too late.—San Bernardino (Cal.) Sun.

The discovery of acetylene may serve as a reminder that the gentlemen who covered many pages of magazines and so many columns of newspapers demonstrating the certainty of the failure of the oil and coal fields, and bewailing the fate of the race when this day came, were wasting their time. Electricity, the development of water powers that electricity has made available, the discovery of acetylene, and the probable discovery of agents even more valuable, make it likely that coal and oil will be displaced from use or relegated to an unimportant position long before the supply of these products in the earth's treasuries have come to an end. It is just as well to avoid crossing bridges before we get to them, and we need not despair of the future of the race till the catastrophe that may threaten it has actually come. The resources of the future may not be inexhaustible, but they are beyond the reasoning of the finite mind.—San Francisco Chronicle.

It is quite common to hear of irrigation works being utilized for the generation of electric power. In all parts of this State where large dams have been constructed or are being constructed or projected for irrigation purposes, the people are contemplating the establishment of manufacturing plants to be operated by electricity generated by the water power developed at the dams. The water power at La Grange developed by the dam of the Turlock and Modesto Irrigation district, which dam cost $650,000, and is the highest in the world, is to be utilized in this way. A combined power and irrigation company has recently been organized at Kaweah, and every day brings news of similar enterprises in other parts of the State. The effects of this union of irrigation and electric power plants is sure to be highly beneficial to the public. The capital invested primarily for irrigation purposes will be earning interest in two directions. This will result in making both irrigation and electric power cheaper to the consumer than either would be without the other. Another good effect will be that irrigation projects, which would not be undertaken on account of the expense or of the small area to be accommodated, can be made protfiable by using the water for the generation of electric power. We have no doubt that this will cause the development of vast agricultural areas, which would otherwise have remained arid and unproductive. The use of water for irrigation and motive power will thus make deserts to blossom as the rose, and convert dry pasture lands into rich farming communities dotted with towns and villages, vocal with the hum of machinery and the songs of prosperous artisans. It is usual to speak of Santa Cruz County as being in no need of irrigation. This is true, comparatively speaking. Our county is not subject to the drouths which afflict other portions of the State. But irrigation would pay even in Santa Cruz. A glance at the market gardens of Chinese and Italians in this vicinity will convince any observer of the truth of this proposition. There are scores of small valleys and mesas in the county, which might be bearing three luxuriant crops a year instead of one crop as at present. All that is needed to treble or quadruple the productive capacity of large Santa Cruz areas is to spread upon them some of the liquid treasures of the mountain streams that go idly to the sea. These streams should be utilized for irrigation and electric power. Santa Cruz should not be behind in the procession, which is moving on towards wealth and prosperity in other parts of the State under the combined banners of irrigation and electric power.--Santa Cruz (Cal.) Sentinel.

MISCELLANEOUS.

Oakland, Cal.—The Electric Specialties Co. has adopted the novel means of advertising of giving evening street lectures on electricity.

Yokohama, Japan.—A double nozzle six-foot, 150-horse-power Pelton wheel, to run under 120-foot head, is being installed in the silk weaving mill.

Salt Lake City, Utah.—F. M. Ulmer is experimenting at the Ontario mine with an electrical device designed to save quicksilver and all other free metals in tailings.

Blue Lakes, Idaho.—I. B. Perrine proposes to construct a dryer for evaporating fruit, in which electricity, presumably to be generated at Shoshone Falls, will be used to generate heat.

Reno, Nev.—A quarterly license, ranging from $25 on corporations whose monthly receipts equal or exceed $10,000 down to $10 on corporations whose monthly receipts are between $1,000 and $2,000, has been levied upon the water, gas and electric lighting industries of this city.

Stockton, Cal.—The estimated steam power consumption in this city is approximately 1750-horse-power, apportioned principally as follows: The Sperry and Crown flour mills about 450-horse-power each, the Union Mill about 300-horse-power, and the Gas Company about 350-horse-power, the present cost of same being about five dollars per horse-power per month.

San Francisco, Cal.—The Electrical Engineering Company reports the sale of two direct-connected double worm gear electric passenger elevators, to be used in Dr. Hertzstein's office building and hospital, and one high-speed electric elevator to be used in the new Cliff House. This latter elevator will have a travel of 125 feet, which is the highest in the city.——W. P. Freeman of Boston proposes to establish a factory for the manufacture of rubber and electrical appliances.——The Safety Electric Elevator Company has been incorporated by J. W. Gentry and others. Capital stock, $100,000.——Among the recent installations made by the Girard Water Wheel Company are the following: A 50-horse-power Girard wheel for the Channel Bend Mining Company near Volcanoville, Cal., and a 200-horse-power Girard wheel for the Ontario Electric Company of Ontario, Cal.——H. A. Russell, late manager of the Pacific Coast office of the Westinghouse Electric and Manufacturing Company, has accepted the selling agency of the General Electric Company.

Reports of the Month.

LITIGATION.

San Francisco, Cal.—The Superior Court has decided, in the suit of Lucien Spencer vs. The Market Street Railway Company for $25,000 damages for personal injuries, that a street railway company is not liable for injuries sustained by a person who has been pushed off a car by some one other than an employee.

Spokane, Wash.—Judge Moore has decided that the original franchise of the Union Light and Power Company has expired by reason of failure to begin operations in good faith within the time specified, or within a reasonable length of time. An injunction preventing the Chief of Police from removing poles that have been erected was therefore denied.

Sacramento, Cal.—The Western Electric Company has brought suit in the United States Circuit Court against the Capital Telephone and Telegraph Company for alleged infringement of Leroy B. Firman's patent No. 252,576, dated January 17, 1882, on multiple switchboards, and on the Watson patent, No. 270,582, of January 9th, 1883.——Judge Catlin, of the Superior Court, has issued a peremptory writ of mandate commanding the Central Electric Railway to sell and supply to E. W. Hale et al., petitioners, such school passes as the petitioners may require to furnish its customers. This the railway company had refused to do because of a contract previously entered into with another business firm, as a result of which Hale Bros. & Co. were prevented from receiving such passes.——Allen L. Clare has sued the Sacramento Power & Light Co. for $50,150 damages and costs for personal injuries alleged to have been received from a charged guy wire.

COMMUNICATION.

Stockton, Cal.—The Gamewell Co. has sold to thecity twelve Standard Gardner boxes, and three 15 inch combined gongs and indicators.

Los Angeles, Cal.—The Board of Public Works has recommended that the bids of Herman de Laguna for $333.00 for a telephone franchise be accepted.

Tulare, Cal.—Seven Excelsior Gamewell boxes, together with a tower-bell and other Gamewell apparatus, constitute the new fire-alarm system recently installed.

Santa Barbara, Cal.—The fire-alarm system has been increased by the addition of eight non-interfering Gamewell boxes, one bell-striker, one combined gong and indicator, and four miles of circuit, all of the Gamewell system.

Eureka, Cal.—The John Vance Mill and Lumber Company has secured the privilege of laying and maintaining a submarine telephone cable from Eureka to the Samoa Mill, via Woodley and the Gunther Islands, across the intervening channel.

San Jose, Cal.—The People's Telephone and Telegraph Company has been incorporated for the purpose of building a telephone system in this city, to work in conjunction with the outside lines of of the California Telephone and Construction Company.

Portland, Or.—The Oregon Electrical Construction Company has been incorporated to build and operate telephone and telegraph lines and branch lines between Portland and Astoria. Capital, $20,000; incorporators, G. F. Huesner, F. C. Miller and J. S. Urquhart.

Tucson, Ariz.—Chas. F. Hoff proposes to install a telephone system at Nogales and Tucson this winter, and will endeavor to connect Phœnix with Prescott and later extend to Flagstaff, after which he will work the other way, from Tucson to Oracle, thence to Mammoth, Florence and Mesa, making a continuous line from Nogales to Flagstaff.

TRANSPORTATION.

Phoenix, Ariz.—The Five Points Street Railway Company proposes to substitute electric for mule power, and to extend its system to Alhambra and Glendale.

San Jose, Cal.—The Board of Trade has pledged itself to use its best endeavors to raise $50,000 towards the construction of the San Jose and Saratoga Electric road.

Santa Cruz, Cal.—The Electric Railway Company denies the report that it will install a power plant, as it is under contract to buy power from the Electric Light Company until next September.

Vancouver, Wash.—An electric road to cost $200,000 is projected to run from this city through Fruit Valley to some point on Vancouver Lake or Salmon Creek.

Stockon, Cal.—James A. Louttit states that work on the Stockton and Lodi Terminal Railway will probably be resumed soon, and that the change in the proposed motive power from steam to electricity is contemplated.

Sacramento, Cal.—The Chamber of Commerce has appointed a committee to call on the contestants along the line of the proposed Orangevale and Sunset Colony Electric Railroad, and endeavor to remove the temporary obstacles in the way of at once starting the work.

Santa Monica, Cal.—The Pasadena and Pacific Electric Railway Company proposes to build a branch line on Oregon Avenue, from Ocean Avenue to Twenty-seventh street.——The first section of the Los Angeles and Pacific Electric Road is completed to the Junction, and is in operation.

Oakland, Cal.—The San Pablo Avenue Cable Line is to be changed to an electric system next year, when it will be extended from Emeryville along San Pablo avenue to West Berkeley, with a loop from the main line to the present terminus of the Telegraph avenue system at the University. Power will be taken from the Temescal power-house.

Seattle, Wash.—The Front Street Cable Railway Company has received from Washburn & Moen a 1⅛-inch cable 30,000 feet in length. This cable was made in San Francisco, and was shipped by rail, as it was too heavy to handle by water.——L. H. Griffith, of this city, left for Central America October 30th, where he expects to build an electric railway.

Santa Barbara, Cal.—The first spike in the new line of the Santa Barbara Consolidated Electric Railway system was driven by Mr. A. Hope-Doeg on October 11th.——The Consolidated Co. has completed arrangements to erect its power-house in Summerland, and will place therein a 500-horse-power engine and boiler, and two 75-horse-power generators.

Los Angeles, Cal.—W. D. Larrabee has been granted a special franchise to construct and operate an electric road for a period of twenty-three months, from Fair Oaks Avenue, on Pasadena street, to the Mountain View Cemetery, with two branches.——Among improvements contemplated by the Los Angeles Consolidated Railway Company are the equipping of the Boyle Heights, East Side, West Lake and Grand Avenue Cable Lines with electricity, and the converting of the Central Avenue Cable engine-house into an electric power-house. A 1000 horse-power engine has been ordered for the latter, and bids are out for a 1200 horse-power engine for the same place. The company is employing about 600 men, 400 of which operate the cars, etc.——The Boyle Heights and West Side Park branches of the Los Angeles Railway Company will be in operation by December.——A bond has been filed by W. S. Hook in the sum of $10,000 for the faithful carrying out of the franchise granted him by the Council for the building of an electric street railway from the intersection of Freeman and Bush streets, southwest on Bush to Hoover, thence south on Hoover to Forrester Avenue.

TRANSMISSION.

MESA, ARIZONA.—Contractor Van Slyke of Phœnix is to build the Consolidated Company's new power house.

LOS ANGELES, CAL.—Ordinance No. 3151 has been passed, granting W. S. Hook, Manager, a street railway franchise.

NEWCASTLE, CAL.—The pole line of the South Yuba Electric Co. is being erected between Newcastle and Roseville, and will reach Sacramento before New Year.

LEMOORE, CAL.—The West Side Land and Canal Co. proposes to irrigate lands on the west side of Kings River, raising the water from wells by means of electric pumping plants.

VANCOUVER, B. C.—F. S. Barnard has notified the City Council that he has procured sufficient English capital to install a transmission plant for operating the street railway and lighting systems.

TUOLUMNE COUNTY, CAL.—The Rawhide mine has ordered a 500-horse-power three-phase G. E. transmission p.ant, the distance of transmission being ten miles, and the generators to be direct driven from Pelton wheels.

SONORA, CAL.—P. J. Sullivan, Secretary of the Buchanan Mining Company, states that the company will build the dam in Hunter Cañon, from which ample power will be derived to operate the Buchanan and Hunter mines by electric power.

CITY OF MEXICO, MEXICO.—Ramon Sanchez has ordered a 600 horse-power three-phase transmission plant to be direct driven from Pelton wheels to operate his paper-mills. The order was placed through S. C. Peck of the International Thomson-Houston Company.

LOGAN, UTAH.—T. A. Davis, promoter of the Hercules Electric Light Co., together with P. M. Munn & Eldon P. Bacon, electrical engineers, formerly of Telluride, Colorado, are about to commence work on the plan, which proposes to transmit 1000 electrical horse-power from the water-power of Logan Cañon, three miles distant.

SAN FRANCISCO, CAL.—The new electric lines on Ellis, O'Farrell, Devisadero, Fillmore, Turk, Eddy and Page streets are now in regular operation.——A force of 2000 men were put at work on the Ingleside extension on November 1st in order that the electric road might be completed to the new race track by Thanksgiving Day.

SACRAMENTO, CAL.—The Central California Electric Light and Power Co. (The North Yuba Canal Co.) has been awarded the county franchise for erecting a transmission line along the county highways, between the Placer County line near Antelope and the city limits.——The Bee expresses the belief that friendly relations exist between the Central California Electric Co. and the Capital Gas Co., and that, if the former does not desire to retail electric light and power, its output will probably be acquired by the Capital Gas Co.

FRESNO, CAL.—Work on the thirty-five mile transmission plant of the San Joaquin Electric Company is progressing satisfactorily. The canal and flume are completed, the reservoir is well under way, and five carloads of copper wire is being strung. The Fresno sub-station is being erected near the corner of O and Fresno streets.——The San Joaquin Electric Co., which will undoubtedly be in operation by February 1st, has thus far arranged to supply power to the Mandary Planing Mill, the Fresno Agricultural Works, the Sperry Flour Mills and the City Water Works.

ANGELS, CAL.—Geo. W. McNear proposes to build a dam about three miles below Bostwick Bar to develop about 2000 horse-power of electric power for operating mines in this vicinity. The Stanislaus River at the site of the dam is 155 feet wide and confined by cliffs 300 feet high, and 40,000 miner's inches of water have been located. Henry L. Smith is to be in charge of the engineering.——Newspapers report that the Utica mines have contracted for a large electric plant to furnish 1000 horse-power for running the company's mills. The water wheels will be run under a head of nearly 1700 feet, and the scheme involves a transmission of eight miles from Murphy's Cañon to Angels.

STOCKTON, CAL.—The Blue Lake Water Company is maturing plans for installing an electric transmission from the Blue Lake region down the Mokelumne River to Wallace, and from there on to this place. Near the Big Bar bridge of the Mokelumne River a fall of 1043 feet can be developed, which is said to be capable of generating 50,000 horse-power. At the present, the company is taking water from its reservoirs, which is used for mining purposes, and, it is stated, that there is sufficient water power now going to waste to generate 8000 horse-power. It is believed that at least 2000 horse-power can be used in this city from the outset, and work will be commenced as soon as sufficient power has been contracted for to pay a reasonable return on the investment.——Still another project for transmitting electric power to this city has been started, the latest scheme being to utilize the water of the Salt Spring Valley reservoir, twenty-four miles distant. It is said that 7000 horse-power can be delivered.——Sidney Newell, Jr., is exploiting an electric transmission project to use the water power of the Blue Lakes, forty miles distant. The installation of two 1000-kilowatt alternators is proposed at an estimated cost of $164,336, exclusive of buildings, water-wheel plant, water developments or local distributing circuits. This project is entirely distinct from the original Blue Lakes scheme that has long been before the public.——The transmission of 2000 horse-power from Mokelumne Hill is talked of.

ILLUMINATION.

TACOMA, WASH.—Since the reduction in rates the business of the city lighting plant has been increased to the fullest capacity of the plant, which is 5000 incandescents and 750 arc lamps.

SAN BERNARDINO, CAL.—The Trustees have advertised for bids for from 60 to 100 arc lights, to be furnished for one year from December 15th, and all bids to be in by noon, December 5th.

CATHLAMET, WASH.—Will Smith expects to put in an electric light plant, to be operated by water power from Birney Creek.——The Clifton Cannery has been fitted up with an electric light plant.

SAN PEDRO, CAL.—J. E. Tult and Charles C. Glass have applied for an electric lighting franchise ——The Long Beach Electric Light Co., having secured the city lighting franchise, has ordered a Corliss engine and dynamo.

OAKDALE, CAL.—L. P. Drexler, of San Francisco, is interested in a project to establish a light and power plant for this place, to be operated by water power taken from the flume across the Stanislaus River, sixty miles above.

MISSOULA, MONT.—H. M. Byllesby, President of the Missoula Electric Light and Power Company, has arranged with the Bonner Company for improved facilities with which to operate the plant, and the work of installation is progressing rapidly.

MODESTO, CAL.—The Modesto Gas Company has secured the co tract for street lighting for one year from December 1st at the rate of $3 per 50-candle-power lamp per month, moonlight schedule, and $4.50 per 50-candle-power lamp per month, all night schednle.

SONORA, CAL.—The Grant Bannister Company has bought the electric lighting plant of the Sonora Electric Light Company, which will be enlarged by the addition of a 200-kilowatt three-phase generator, and will be moved about four miles out of town, where water power is available.

SACRAMENTO, CAL.—The South Yuba Co. has been granted the privilege to erect poles for its proposed transmission lines in Sacramento County.——The annual contract for lighting the city has been awarded to the Sacramento Electric Power & Light Co. for $8.75 per lamp per month. The former rate was $14.95 per month.

Minas Prietas, Ariz.—Thomas Douglas, of San Francisco, has been appointed electrician of the Minas Prietas mills, mines and telephone lines.

Montesano, Wash.—Albert Daub is to light the city for two years in return for electrical supplies valued at $741, which the city has on hand.

Cottage Grove, Or.—Mr. Anderson is putting in a plant for city lighting in a building adjoining Stone's mill, from which power will be taken.

Anaconda, Mont.—New water wheels, dynamos, and other equipments are to be placed in the plant of the Anaconda Light and Power Company.

Aberdeen, Wash.—E. B. Benn and C. R. Green have leased the Electric light plant for one year, and will inaugurate needed changes in the system.

San Leandro, Cal.—A special election will be held on December 16th for the purpose of incurring an indebtedness of $10,000 for an electric light plant.

Bingham, Utah.—O. B. Hardy and W. J. Moorhead have received an electric franchise for operating a light and power plant in the West Mountain Mining district.

Redwood City, Cal.—J. George Gardner is installing an electric lighting plant here, and proposes to extend lighting circuits to Menlo Park, Palo Alto and Woodside.

Eureka, Cal.—The National Incandescent Lighting dynamo formerly used on the Steamer Humboldt has been taken from the wreck of that vessel and will be installed on the steamer National City.

Salt Lake, Utah.—The Gas and Electric Light Company proposes to erect a business block on State street in which will be located its offices and the distributing station for the Big Cottonwood plant.

Redwood City, Cal.—Chas. Jones has placed an isolated lighting plant in his residence, consisting of a 5-kilowatt Westinghouse multipolar dynamo direct, driven from a small Pelton water-wheel, operating under 500-foot head.

Riverside, Cal.—The Redlands Electric Light and Power Co. have contracted to furnish the city with 200 horse-power of electricity for ten years at $36 per horse-power per year for continuous service, and the amount of power to be increased to 600 horse-power when the city may desire it.

Nevada City, Cal.—K. Casper proposes to supplement the present 1000-light Heisler incandescent system with a 200-kilowatt polyphase generator for delivering light and power. The services of W. Stuart-Smith and Sidney Sprout have been retained as consulting and supervising engineers.

Oakland, Cal.—The Oakland Light and Motor Co. has elected the following officers for the coming year: Thomas Addison, president; W. S. Harlow, vice-president; Edward Barry, secretary. The board of directors consists of Thomas Addison, F. F. Barbour, W. S. Harlow, W. L. Prather and Edward Barry; superintendent, R. P. Valentine.

Stockton, Cal.—The Stockton Gas, Light and Heat Company proposes to place a large gas engine in its electric light plant, in view of which it has entered into a contract with Jerome Haas to sink a well for natural gas at the corner of Ninth and Hunter streets.——The Stockton Gas and Electric Co. contemplates manufacturing ice.

San Francisco, Cal.—The Pan Handle of Golden Gate Park has been lighted by arc lamps, as the result of the regent agitation on the subject.——The newspapers state that an agreement has been reached between the San Francisco Gas Light Company and the Edison Light and Power Company, by which there are to be no more hostilities at present.

Salt Lake City, Utah.—The Salt Lake and Ogden Company has materially enlarged its plant by the addition of new dynamos and machinery preparatory to meeting the competition of the Citizens' Electric Light Company.——The incandescent installation in the Silver King Mine has been completed. A. V. Officer has been appointed superintendent of the Citizens' Electric Light Company.——A rate war is in progress between the Citizens' Company and the Salt Lake and Ogden Company, as a result of which arc lights have been put in at $2.50, where they formerly brought $10 50.

San Francisco, Cal.—The John M. Klein's Electrical Works has succeeded W. J. O'Connor to the Pacific Coast agency for the Sunbeam Incandescent Lamp Co.——The Mutual Electric Light Company has enlarged its plant by the addition of a 60-kilowatt Westinghouse alternator.——The contract for the steam and electric plant of the Parrott building has been awarded to the Union Iron Works, which will install six 100-kilowatt and two 30-kilowatt, 110 volt generators, each direct connected to a triple expansion marine type engine. Internal fired boilers are to be used, and the plant, which is to be run condensing, is to be wired for 320 constant potential arcs, 5000 incandescent and 15 Sprague-Pratt elevator equipments.

San Jose, Cal.—An understanding between the Electric Improvement Company and the San Jose Light and Power Company is believed to have been effected, though it is denied by the officials.——The Board of Trade has passed a strong resolution favoring municipal ownership of an electric lighting plant, and City Attorney W. B. Hardy has rendered an opinion to the Mayor and Common Council to the effect that the City has full power to regulate the price of artificial light. The reports of combination between the two lighting companies seem to be confirmed by the fact that the price for arc lamps has been increased fifty cents per week.

Alameda, Cal.—It is proposed to add a 350-horse-power compound condensing Corliss engine and boilers, and a 2500-light alternator to the municipal lighting plant.——Al V. Fisher has been appointed assistant engineer and collector of the city lighting plant.——The City Trustees have about concluded to take down the electric light masts.——Expert J. A. Sansome has rendered a report showing that the cost of operating the city electric light plant for five years ending March 31, 1895, to be $64,045.67, or $12,809.13 per year. The construction per year is $3,000, the maintenance per year $9,743; the cost per lamp for 90 lamps, per year, is $106.25, and the cost per lamp, per month, is $8.25.

Los Angeles, Cal.—W. B. Carter will place an electric light plant in the $15,000 resort he proposes to erect at the lake in Echo Park.——The City Electric Power and Lighting Company proposes to furnish all city buildings with electric light free of charge, provided a special electric light franchise be granted it. The Board of Supervisors has amended the license ordinance so that a tax of $15 per month shall be imposed on gas companies, while the tax on electric lighting companies shall be graduated as follows: Plants operating less than 500 lights, $2 per month; between 500 and 1000 lights, $10 per month; over 1000 lights, $15 per month.——F. N. Meyers has been elected President of the City Electric Power and Lighting Co.

Seattle, Wash.—A. L. Hawley, assistant manager, and J. I. Robinson, secretary of the Union Illuminating Company, have resigned, to take effect November 1st.——The combination that has been in existence for many months between the Union Electric Company and the Seattle Gas and Electric Light Company, which has been operating as the Union Illuminating Company, has been dissolved, and its component members are again in active competition.——F. H. Osgood, A. L. Hawley and J. T. Robinson have submitted a tender to build the city a lighting plant, with poles or conduits, supplying everything for 665 incandescent 15-candle-power lights, and 81 arcs of 2000-candle-power at $7.25 per month for the latter, and $1 per month for the incandescent. The city is to purchase the plant in three years.

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Some Tests of Air Compressors.

By *A. E. Chodzko, M. E.*

Edward A. Rix, P. E.

THE recent tests made by the military authorities on the dynamite guns at Fort Point, San Francisco, may lend some interest to a few particulars regarding air compressing plants, which form the vital element of this installation.

The contract for the construction of the mechanical part of it, with the exception of the guns and their immediate fixtures, was awarded by the Pneumatic Torpedo and Construction Company of New York, and to the Fulton Engineering and Ship Building Works of San Francisco, upon the plans and special designs of Mr. E. A. Rix, P. E., who supervised the construction of the plant.

The compression of air is made in three stages, from the atmosphere to the working pressure of 2,000 lbs. effective per square inch. It is performed in two sets of horizontal engines, to both of which the subsequent description applies, they being in all respects entirely alike. The steam is supplied by four boilers, of the horizontal tubular type, of 750 horse-power capacity, arranged to work either with natural or with forced draught. As will be seen in the annexed outline cut (Figure 3), two steam cylinders connected to the same shaft by cranks at an angle of 145 degrees from each other, each actuate two air cylinders in tandem, that is, through their piston tail rods, there being on one side one low pressure and the intermediate or second stage cylinder, and on the other side one low pressure and the high pressure or finishing cylinder. This duplex set therefore comprises two steam cylinders (Figure 4), operating two intake cylinders (Figure 5), wherein the atmospheric air is compressed to about seventy-five lbs. effective, together with one intermediate cylinder (Figure 6), increasing the air pressure from seventy-five to about 400 lbs. effective, and one high pressure cylinder (Figure 7), which takes the air at 400 lbs. and compresses it to 2,000 lbs. effective. The intake or low pressure cylinders are double acting, that is, they have inlet and discharge valves at each end, while the intermediate and high pressure cylinders are single acting, that is, provided with valves at one end only, their pistons being plunger rams with spherical heads, connected to the tail rods of the intake cylinders.

The special purpose which these compressors have to serve made their design and construction subservient to conditions at entire variance with the lines upon which an air compressing plant is usually established. The main object of the designer, when a large power is to be used, as in the case of the Fort Point installation, is commonly to secure the greatest possible economy in the production of the compressed air. In the present instance compound condensing engines of the most approved type, and air cylinders working at a moderate linear piston speed, would present themselves to the mind as advisable. Such engines would be established

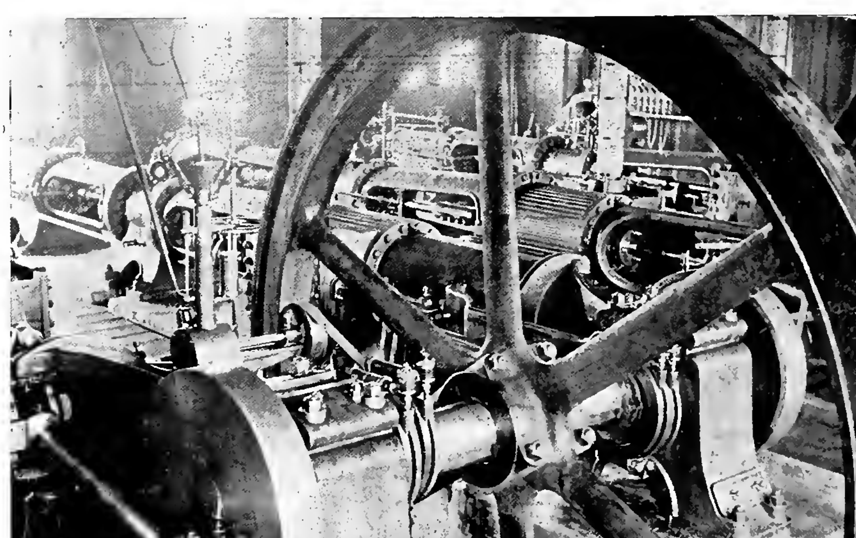


FIGURE 1—*A General View of the Rix Air Compressor Plant.*

in view of a regular working speed, or approximately so, and everything would be provided to give the economical appliances a chance to work to their full advantage. At Fort Point the primary requirement was to have a plant as little liable as possible to getting out of order. Solidity, simplicity and endurance were therefore the main points to be considered, economy being a desirable but decidedly an accessory feature. Upon these general lines, supplemented by conditions of capacity within a given time, of efficiency in the means of cooling the air and of practical effectiveness of several important parts, the present plant was designed, built and erected. The steam engines are non-condensing and each cylinder acts independently, that is, no compounding has been adopted. The valves are provided with Meyers' cut-off, regulated by hand, the governors merely acting on the throttle in case of racing. The cranks are set at the angle heretofore indicated, in order that the machine may be balanced as nearly as possible and yet the engines be able to start in any position.

In the air cylinders the greatest care has been used to secure a cooling efficiency as high as possible. The heads and the barrels of the cylinders are water-jacketed, the water discharge pipes from the jackets being in full view and easily accessible, and the supply of cooling water being regulated according to its temperature at the discharge.

A very elaborate and effective system of intercoolers has been established between the intake and intermediate cylinders, and also between the intermediate and high pressure cylinders. These intercoolers consist of nests of copper pipes extending under the floor in cemented trenches, where a stream of cold water is constantly running. The proportions of these intercoolers have purposely been made very ample, and their effectiveness is fully demonstrated by the low temperature of the air before it enters the intermediate and the high pressure cylinders, which are given hereafter. A similar cooler is provided for the air at working pressure after it leaves the high pressure cylinder and before reaching the twenty-four forged steel storage tubes which, through a complete system of pipes and manifolds, and also a compact arrangement of valves, can be set in communication with each particular gun, or if so desired, with a supplementary storage supply located in the foundation of the guns.

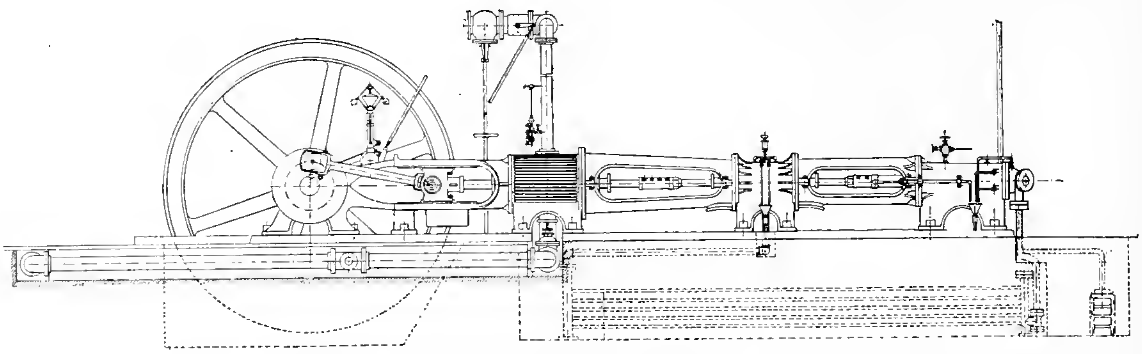


FIGURE 2—*Elevation of the Rix Three-Stage Compressors for 2,000 lbs. Pressure.*

That the demand upon the compressors may vary during action within widely distinct limits was exemplified by the fact that while 360 feet per minute is generally considered as a limit of piston velocity in water-jacketed cylinders, this velocity has been, during part of the trials, carried to 568 feet, or an excess of fifty-eight per cent. At this high rate of speed no undue heating could be observed in the moving parts, and the absence of jarring and of trepidations was the best evidence of the remarkable strength and steadiness of the plant. Of course when working at high speed, no claim is nor could be entertained to maintaining a satisfactory cooling efficiency in each individual cylinder. As before stated, the intercoolers are of sufficient size to deal with the heat liberated during the compression even at high speed. But when the period of compression and of course the

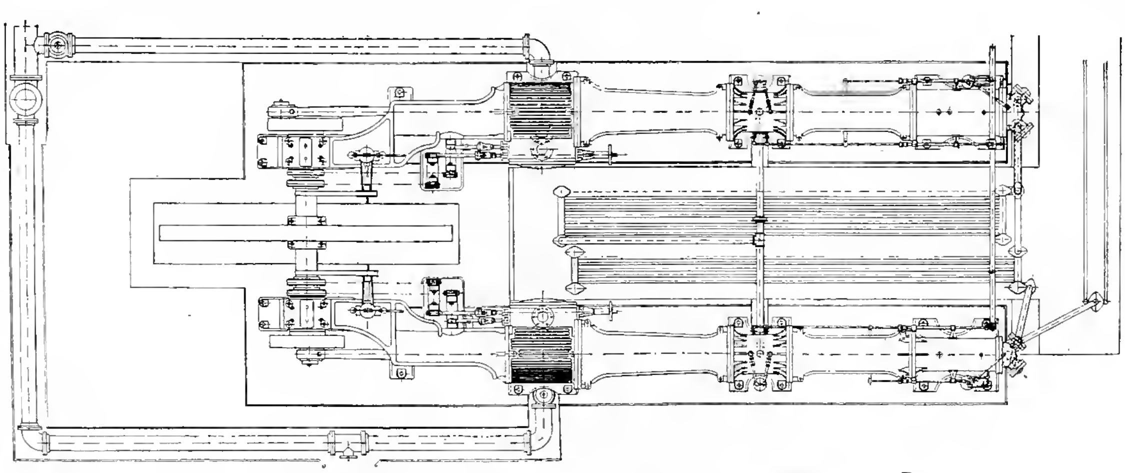


FIGURE 3—*Ground Plan of Rix Three-Stage Compressors for 2,000 lbs. Pressure.*

period of effective possible cooling, lasts two-fifteenths of a second, the heat units passing through the cylinder walls during that time cannot be expected to be many. It might be argued that the Riedler compressors in Paris work at a nominal piston velocity of 550 feet, and occasionally 733 feet per minute, but aside from the fact that the use of a spray for cooling and of mechanically moved valves are both combined to reduce the rise of temperature, the pressures in the two-stage Riedler compressor are considerably lower, the air being sent into the mains at only 118 lbs. gauge per square inch, an insignificant pressure as compared to 2,000 lbs. per square inch.

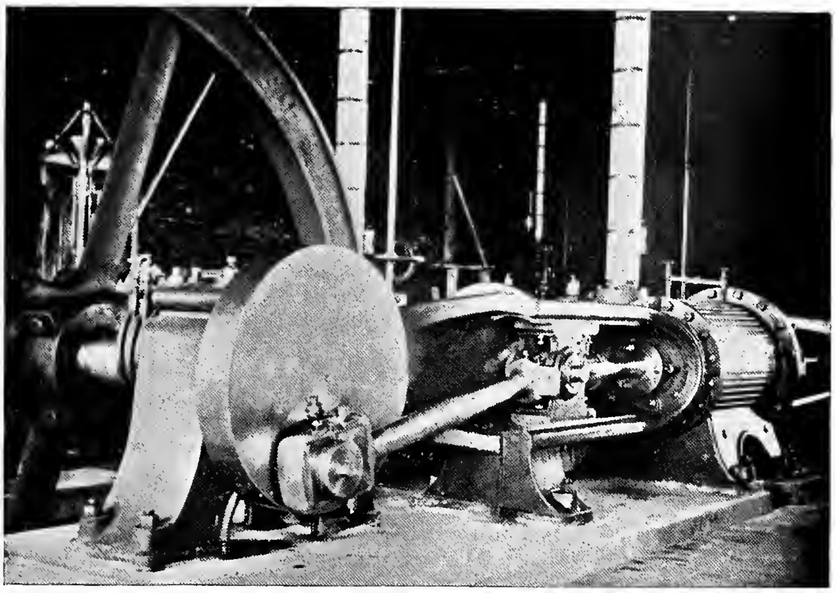


FIGURE 4—*Meyers' Cut-off Engine, Operating Rix Compressors.*

Another point of interest in the Fort Point plant is the absence of leakage at the stuffing boxes of the intermediate and high pressure rams. This point has been the cause of much annoyance in similar plants built elsewhere, and the present arrangement is the outcome of long and costly experiments. The friction in a running joint capable of holding 2,000 lbs of air pressure against the atmospheric, is necessarily enormous, and after the nature, the shape and the size of the packing had been determined upon, it became necessary to keep the packing sufficiently cool to prevent its rapid wear. This is effected by a special circulation of cold water inside the rams, the arrangement being quite apparent on the general plan, and that it is successfully effected can be easily ascertained. This water circulation also partly contributes to cooling the air under compression. At the nominal rate of speed of about 400 feet per minute of piston velocity, the compressors supply to the storage tubes 460 cubic feet of air per hour at 2,000 lbs. gauge. The annexed abstract from trials made in view of timing the production of the compressors gives interesting evidence of the effectiveness of the intercoolers and of the regularity of the temperature of air at its entrance to each cylinder. For a range of final pressures comprised between 800 and 2,000 lbs. effective, the variation of temperature was only eight degrees Fahrenheit for the intermediate, and three degrees Fahrenheit for the high pressure cylinder, the temperature of the engine room being seventy-five degrees Fahrenheit.

Gauge Pressure Lbs. per Square Inch	Fahrenheit Temperature at Entrance to		
	L.P. Cyls.	I.P. Cyls.	H.P. Cyls.
800	71	67	66
900	71	68	67
1000	71	69	67
1100	71	69	67
1200	71	70	68
1300	71	70	68
1400	71	71	68
1500	71	72	68
1600	71	72	68
1700	71	74	69
1800	71	74	69
1900	71	73	69
2000	71	72	69

The discharge temperature of the low pressure cylinders gradually increased and then remained stationery at 320 degrees Fahrenheit. The intermediate cylinder discharge likewise attained a temperature of 292 degrees Fahrenheit, and the high pressure cylinder, beginning at 375 lbs. per square inch and at a temperature of sixty-six degrees Fahrenheit delivered from the intercoolers, gradually rose in temperature as the pressure increased until it reached 2,000 lbs., and after running at that pressure for one hour the thermometer indicated its maximum, viz., 358 degrees Fahrenheit. The sum total of those temperatures, viz., 970 degrees, as compared to the adiabatic temperature of single-stage compression to 2,000 lbs., which is 1762 degrees Fahrenheit, indicate the work saved by the three-stage method of compres-

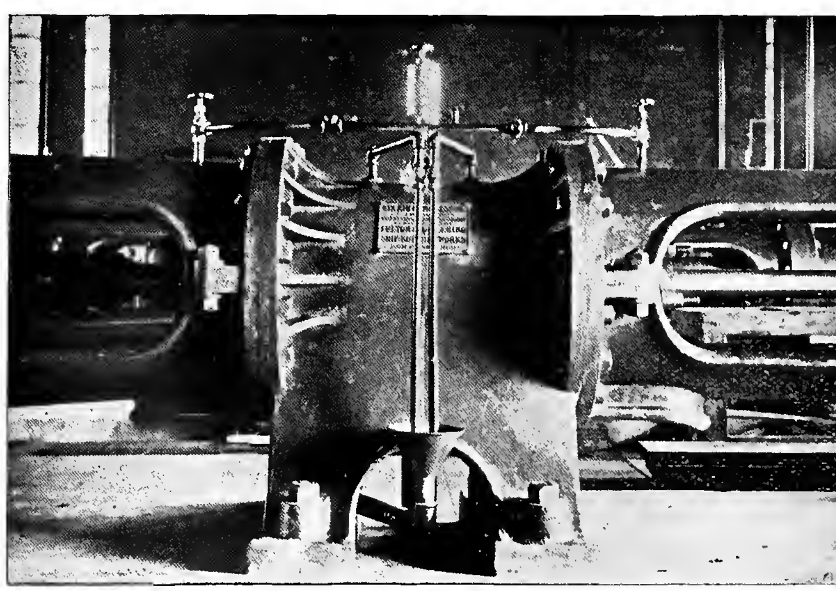


FIGURE 5—*One of the two Initial Air Cylinders of the Rix Compressors.*

sion combined with the jacket and ram cooling devices. The compression throughout the whole range was practically regular, being on an average 115.1 lbs. for each 500 revolutions of both machines.

The mean of many cards taken from the steam cylinders, which is reproduced in Figure 10, showed that each compressor absorbed 342.61 I.H.P., while the cards from the three air cylinders showed 293.78 I.H.P. for each compressor. The work then absorbed by the friction, inertia, etc., was 48.83 I.H.P., or 14.2% of the indicated power employed, showing a mechanical efficiency for the compressor of 85.8%, which is high, especially in view of the facts that the engines were new and consequently stiff to some extent, and also that some extra friction is developed at the ram stuffing boxes as compared with a compressor working at the usual air pressures.

The resisting load of 48.83 H.P., while the compressors were doing full duty, may be compared with the friction load on the machine without air pressure, and an interesting result obtained. Cards taken showed that this friction load was 32.4 H.P., being .663 of the resisting work under load and showing an increase of 50.7% in the resistances between no load and full load. The combined indicator cards illustrated herewith (Figure 10), are plotted from actual cards and show a saving of 36.8% over adiabatic single-stage compression.

The boilers for this plant are of the return tubular type and manufactured by the Chandler & Taylor Company of Indianapolis, Ind. They are seventy-two inches in diameter by sixteen feet long, and of a nominal H.P. of 500, which was increased by the forced draught employed to about 750 H.P. These boilers were tested to 150 lbs. to the square inch, and fully satisfied the requirements of the Treasury Department. The forced draught was employed because it was not considered desirable to continue the stacks above the roof and thus give an opportunity for invading forces to discover the position of the plant. A short stack, about fifteen feet in length, was therefore erected. The forced draught is instituted by two Sturtevant fans, with engines attached, having cylinders three inches in diameter by a three and a half-inch stroke. These fans each deliver 12,000 cubic feet per minute of free air through a twenty-two-inch main, which, passing underneath the battery of four boilers, is connected to each by a ten-inch outlet underneath the grate bars. It was found during the test that these fans need be run only to about 60% of their capacity. The engines exhaust their steam into two National heaters of 300 H.P. each, which furnished feed water to the boilers, at a temperature of 200 degrees Fahrenheit.

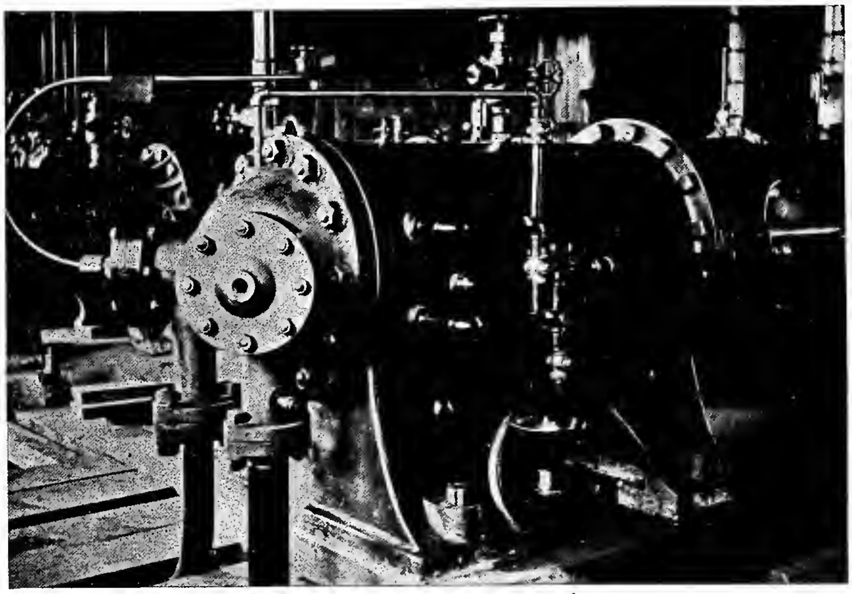


FIGURE 6—*The Intermediate Ram of the Rix Compressors.*

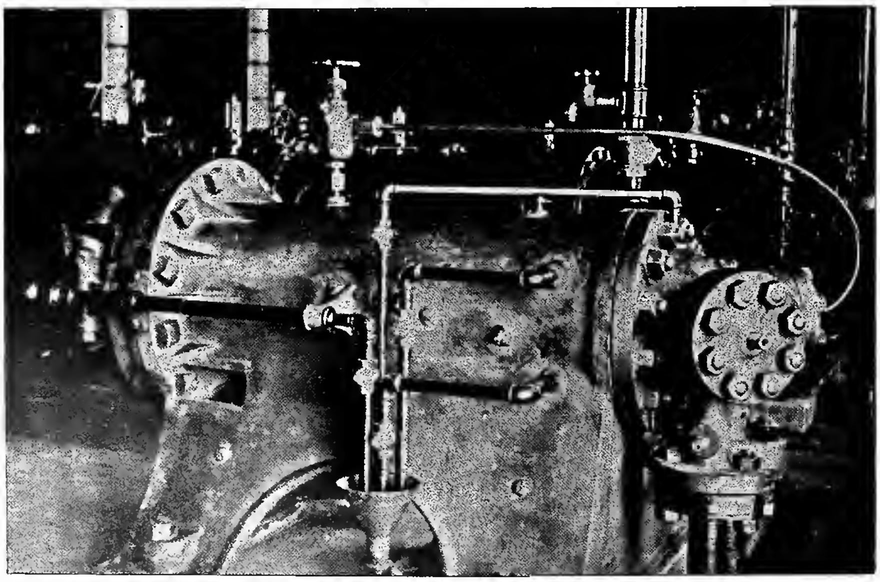


FIGURE 7—*The High Pressure Ram of the Rix Compressors.*

The feed pumps are of the Deane type, being duplex and two in number; the steam cylinders being six inches, the water cylinders being four inches and the stroke being six inches. At a slow piston speed these pumps furnished all the necessary water, which was drawn from the pits after being heated by the air from the compressors. As an auxiliary there are installed alongside of the feed pumps two Nathan injectors of 300 H.P. each, which are amply sufficient to furnish all of the water necessary to feed the boilers. During the test for rapidity of firing, while the plant was supposed to be strained to its utmost, the firemen had ample time to observe the operation of the compressor plant, showing that the boilers were more than sufficient to supply the steam necessary for the

proper operation of the compressors. The electrical equipment of the installation, which was furnished by the Electrical Engineering Company of San Francisco, consists of one thirty-five K.W. compound wound dynamo, shown in Figure 8, and capable of being worked up to

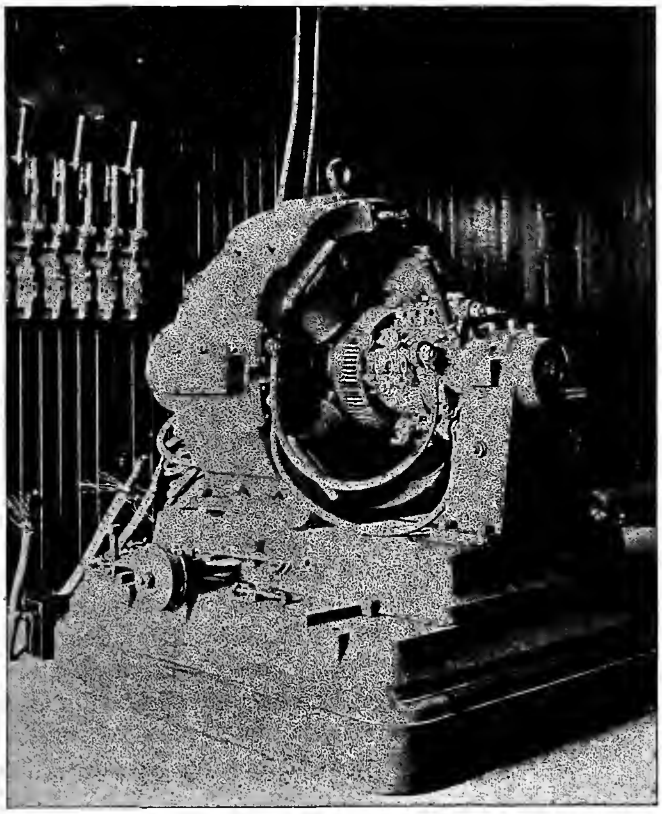


FIGURE 8—*The 35 Kilowatt Generator, manufactured by the Electrical Engineering Company of San Francisco.*

25% in excess on its rated capacity for thirty minutes without undue heating. This dynamo, which is driven by a fifty H.P. Armington & Sims' engine (Figure 9), operates about forty lights in the power house and furnishes the current necessary for operating the electric motors by which the guns are handled. A substantial switchboard, consisting of slate slabs bolted to an iron frame, has been erected immediately back of the dynamo, and on which are placed the necessary fuse blocks, Weston instruments and three 300 ampere main line switches. From the switchboard about 800 feet of lead-covered concentric cable is run through an underground conduit in separate circuits to the motors operating the three guns.

The compressed air, after leaving the compressors and being confined in the storage tanks, is distributed to the three guns independently, through a manifold of bronze, having attached five gauges, two registering 2,000 lbs. and three registering 1,250 lbs., all so arranged with valves that any or all of the guns could be operated at once. This air is carried to the underground storage reservoirs of the guns, through a pipe having an outside diameter of $2\frac{1}{2}$ inches and inside diameter of $1\frac{5}{8}$ inches, and duly tested to 3,500 lbs. to the square inch for tightness. From the guns to these manifolds there are also three copper pipes, each $\frac{1}{4}$ inch inside diameter by $\frac{1}{2}$ inch outside diameter, to register the pressures at the manifolds that are contained in the carriages of the guns. This is in general the description of the air compressing plant.

We now come to speak of the guns themselves, which were manufactured at the West Point foundry on the Hudson, each fifteen inches in diameter with a length of fifty feet. Each gun is perfectly balanced on its carriage, weighing about seventy tons, which is in turn mounted upon concrete foundations. The tests of these guns for their mechanical efficiency, which may be called their ease of operation, showed that they could be traversed by the electric motors which were situated in the gun carriage, in an average of one minute throughout the entire 360 degrees, and they could be changed from extreme elevation to extreme depression in from eight to eleven seconds. Any one familiar with the length of time necessary to operate ordinary powder guns by hand, will appreciate the fact that this facility of operation is marvelous.

For testing these guns for mechanical efficiency the requirements were, first, that forty-five shots should be fired in the first hour and thirty shots in the hour succeeding. Inasmuch as the wastage of air would be the same whether actual projectiles were fired or whether the air was simply wasted through the muzzle of the gun in "air shots," no projectiles were fired in this test, and it was found for the first hour that forty-five shots were fired, and the compressors running at their normal

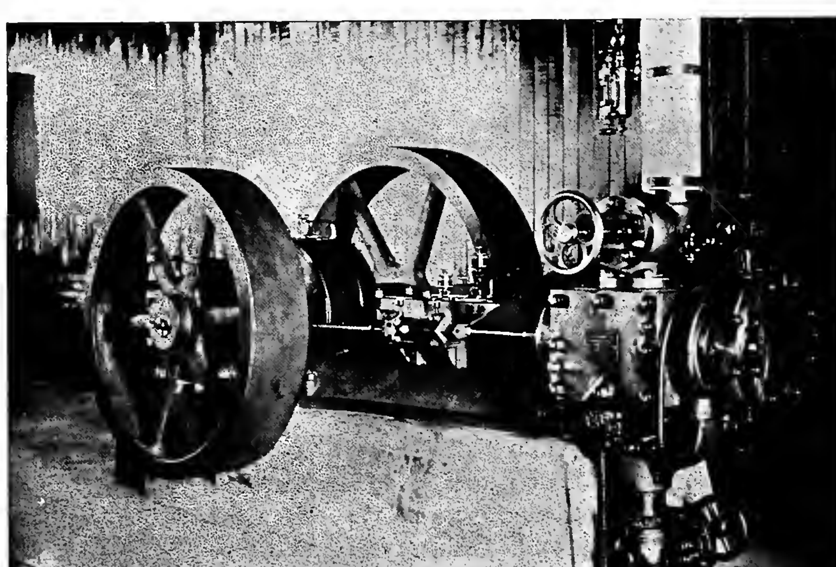


FIGURE 9—*Armington & Sims' Engine, driving the "Double E" Co.'s Dynamo.*

speed registered a final pressure of 1,800 lbs.; it being thus demonstrated that the compressors were amply sufficient to maintain any requirements which might be placed upon the gun. Twenty air shots were fired to ascertain the utmost rapidity with which the guns could

be discharged, and the same were discharged in seven and one-half minutes, though the contract did not require that these shots should be discharged inside of thirty minutes; it being thus demonstrated that the compressors and the guns were amply capable to maintain the test required by the government.

The test for rapidity of firing with actual projectiles next took place. The projectiles used were pieces of gas pipe twelve inches in diameter and eight feet long, loaded with sand. The weight was 1,040 lbs. Each one of the three guns was required to fire five of these projectiles in twenty minutes. The test developed the fact that these projectiles were all discharged from each gun within eight and one-half minutes, and they were by far the most interesting feature of the whole test.

Having no means for maintaining the accuracy of their flight, these projectiles were nevertheless thrown for the first one-half distance of their flight with precision, that is, they maintained the position of a well-directed projectile, after which they tumbled end over end and fell into the sea. Without any plain table measurements being taken upon them, they apparently fell quite accurately within a small target. The time of flight of these projectiles averaged about nineteen seconds for about 2,200 yards.

The questions of rapidity of firing and of loading having been determined, the next test was one of accuracy, and the live projectiles were discharged from these guns at a distance of 5,000 yards. The projectiles used were of the eight-inch caliber, the difference in diameter being made up by wooden pistons in four sections, so that the wooden pieces would fly off after the projectiles had left the gun, leaving it clear to make its flight. The first projectile flew 5,000 yards and exploded; the second projectile flew 5,070 yards and exploded; the third projectile flew 5,015 yards and exploded; the fourth projectile flew 5,040 yards and exploded; all of these projectiles being plotted on a plane table in a rectangle seventy yards long by twenty yards wide; the time of flight being about twenty-seven and one-half seconds.

As a matter of experiment, two shots were fired into the hills of Marin county at a distance of 3,550 yards, each with the eight-inch sub-caliber shell, loaded with 100 lbs. of dynamite, the first shot being fired five days previous to the second shot. The shots struck within forty-five yards of each other, and exploded in a perfectly satisfactory manner, in fact the pits caused by the explosion joined each other. The larger shells, viz.: the fifteen-inch full caliber projectiles, being eleven feet long and weighing some 1,050 lbs., loaded with 500 lbs. of nitro-gelatine, were thrown into the sea at a range of an average of 2,100 yards. They exploded practically upon striking the water, throwing into the air a column of water about 100 feet in diameter at the base, and, from the levels taken at the gun, about 400 feet in altitude. The tests as above enumerated were perfectly satisfactory in every respect, and exceeded in every way the requirements of the government. There were no mistakes made and no delays whatever caused by the air compressing plant or the gun plant, which probably exceeded the government requirements in an aggregate of over one thousand per cent., if the various excess percentages of the different tests were added together, and which reflect great credit upon the manufacturers of the power plant, the constructing engineer, the manufacturers of the guns and projectiles, and also the Pneumatic Torpedo and Construction Company of New York, which contracted for and thus successfully carried to completion their contract with the government.

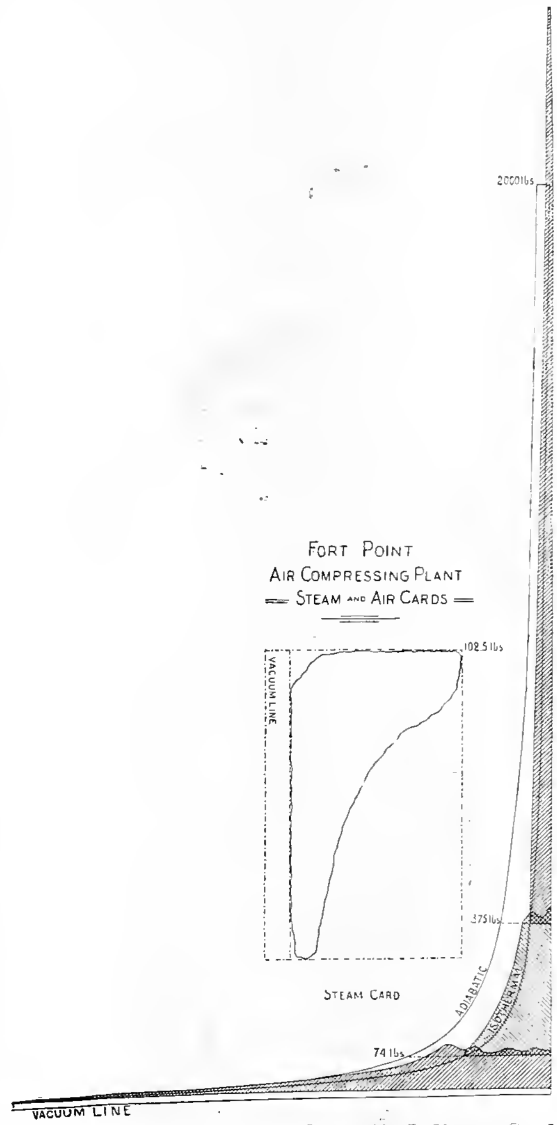


FIGURE 10—*Steam and Three-Stage Air Indicator Cards, plotted from actual cards at 100 r. p. m.*

NOVEL FLYWHEEL CONSTRUCTION.

Among the most recent and novel applications of wire is the wire flywheel lately erected at the Mannesmann Tube Company's works, Germany, and especially notable in view of the well-known fact that heavy flywheels driven at high velocities present such dangers of breaking asunder from the great centrifugal force developed. The wheel at the factory mentioned is described by "Hardware" as a cast-iron hub or boss, to which are attached two steel-plate disks or cheeks, about twenty feet in diameter. The peripheral space between the disks is filled in with some seventy tons of No. 5 steel wire, completely wound around the hub, the tensile resistance thus obtained being found to be far superior to that of any casting. This huge flywheel is driven at a speed of 240 revolutions per minute, or a peripheral velocity of 2.8 miles per minute, or approximately 250 feet per second, which is said to be nearly three times the average speed of any express train in the world. For such a constructed flywheel the length of wire is estimated at about 250 miles.

RECENT SIEMENS-HALSKE INSTALLATIONS.

The Siemens & Halske Electrical Company, since its combination with the Union Iron Works of San Francisco has been effected, has installed several interesting plants, one of the neatest of which is that shown in the accompanying illustrations, reproduced from photographs of the lighting plant of the Occidental Hotel, San Francisco. In this installation a fifty KW. 125-volt dynamo is driven direct by a vertical compound engine, having dimensions of nine by seventeen inches by a ten-inch stroke. The engine is of the cruiser type, with special finish, large bearings, and conforms with government specifications throughout, operating at 280 revolutions per minute.

Practical counterparts of this equipment, with the single exception that the dynamos deliver current at a potential of 220 volts, have just been installed in the National Home for Disabled Veteran Soldiers at Santa Monica, Cal. The plant consists of two fifty-five KW. and one twenty-KW. Siemens & Halske dynamos, the former being direct connected machines, while the latter is driven by belting. This installation, which is also equipped with twelve Manhattan arc lamps, is noteworthy in that it is the first plant on the Pacific Coast to operate 220-volt incandescent lamps throughout.

The 220-volt incandescent lamps now used are of the Edison and Bryan-Marsh makes, which are undergoing efficiency and life tests.

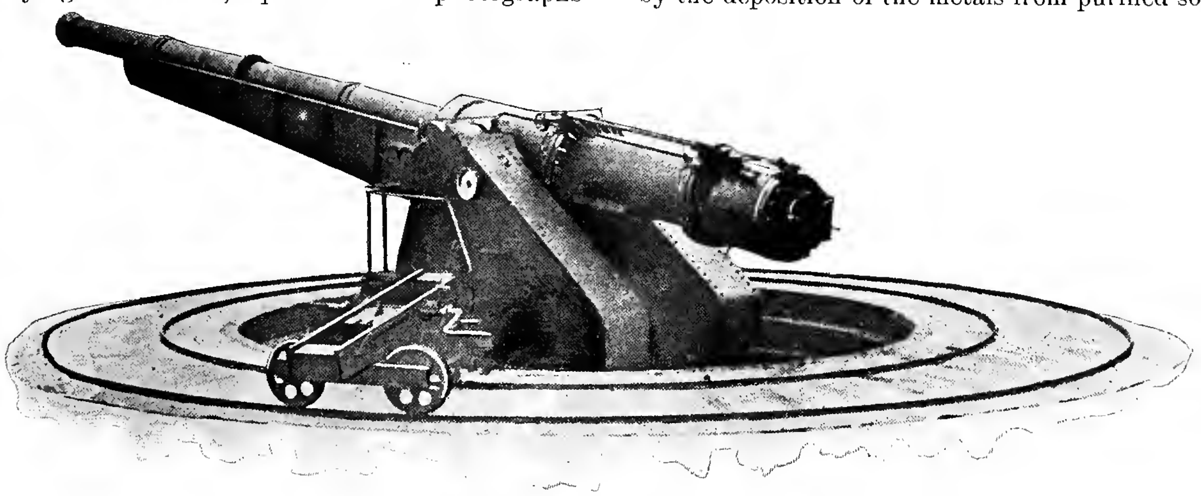
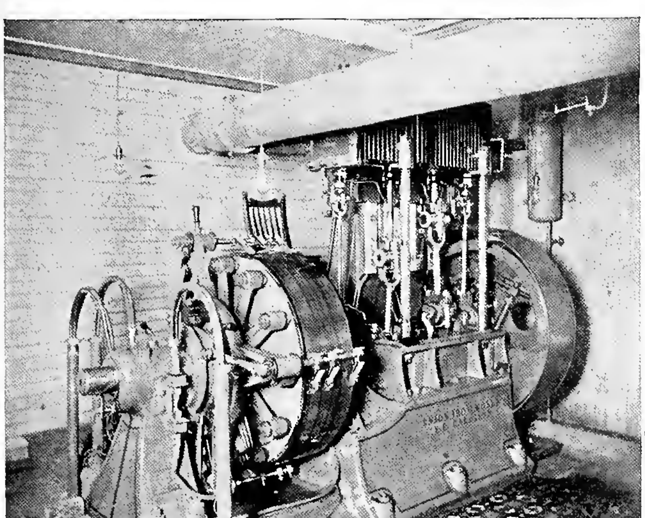


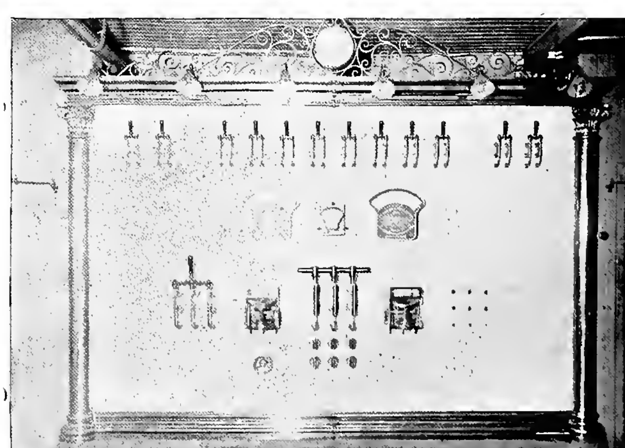
FIGURE 11—*One of the Three Pneumatic Dynamite Guns at Fort Winfield Scott, San Francisco.*



Recent Siemens-Halske Installations.

THE PRODUCTION OF PURE ZINC.

Messrs. Herren-Mylius and Fromm point out that to try to purify zinc by dry methods leads to no favorable results. The wet process can be carried out only with the aid of electrolysis, and this can be done in two ways —by the deposition of the metals from purified solutions with insoluble anodes, or by electrolytic refining with the use of soluble anodes of zinc. In their researches they used pure solutions of sulphate of zinc, and obtained the following results: The pure zinc of commerce contains in all cases noticeable quantities of cadmium, lead and iron. A solution of sulphate of zinc can be purified electrolytically so that chemical analysis cannot find any heavy foreign metals; zinc oxide is easily obtained by a chemical process, with the same purity; the electrolytic zinc obtained from zinc sulphate or oxide contains appreciable quantities of platinum, which comes from the anode; the purest zinc is obtained by the repeated electrolytic reduction of the metal in basic zinc sulphate solutions, from which it is obtained in a spongy state, and must be melted in vacuum. The metal so obtained is not absolutely pure, but contains at least 99.99 per cent. of zinc. With the electrolytic decomposition of zinc, the secondary decomposition of water cannot be prevented entirely.



Recent Siemens-Halske Installations.

——"Allow me to congratulate you upon the varied and interesting matter contained in the last issue of the 'Journal of Electricity.' You are not only getting to the front, but have already got there," writes the president of a prominent concern that has advertised in this paper since its first issue.

FEATURES OF THE PORTLAND TRANSMISSION HITHERTO UNPUBLISHED.

BY GEO. P. LOW.

There has recently been given out for publication in the electrical journals, evidently emanating from the General Electric Company, a well-illustrated article describing the new three-phase transmission plant of the Portland General Electric Company, recently placed in operation between the falls of the Willamette River at Oregon City and Portland, Oregon, which omits to indicate many important features concerning that most interesting installation.

Station B, as the new power house containing the three-phase generators is termed, is located on the west bank of the Willamette River at the falls, and immediately alongside the upper canal of the Willamette Locks and Transportation Company, by means of which steamers are enabled to pass the falls. The station, as far as erected, is of massive concrete construction, and its general design is clearly shown in the outline drawing accompanying (Figure 6). From this it will be seen that both water wheels and generators are of the vertical-shaft type, and owing to the extreme rise and fall of the water in the lower river, sometimes marking an extreme variation of nearly forty feet, it has been necessary to install two sets of turbines for high head and low head, respectively, for each generator, as set forth in the drawing, and more fully described in recent numbers of the electrical press. The generators, which, as stated, are of the three-phase type, each have a capacity of 450 KW. Each contains twenty field poles, is operated at 200 revolutions per minute, and delivers 6,000 volts to the line without the intervention of step-up transformers. The present plant contains but three such units, though it will, when completed, contain twenty similar machines, having an aggregate output of about 13,000 H.P.

In addition to these generators the station contains two multipolar exciters, having a capacity of 250 KW. each. These each contain six poles, and operating at 125 revolutions give 500 volts. These generators, which are over-compounded, have been installed to serve as exciters for the completed station, hence their capacity is greatly in excess of the present demands, and one of them is now being used for operating the three-mile electric railway system that the Portland General Electric Company is running between Oregon City and its manufacturing townsite, Willamette Falls. Here is located about 1,600 acres of land, which is laid out to meet the requirements of a manufacturing city, and to which will be delivered electric power in any quantity desired. Situated as it is, at the junction of the Willamette and Tualatan Rivers, but a short distance above the falls, it is within easy reach of Portland, the commercial center of the Pacific Northwest, and will in all probability soon become the Lynn of that portion of the country. At present the city of Willamette Falls contains probably 800 inhabitants, many of whom find employment in the Capen shoe factory, its solitary industry and which, by the way, is operated by electric power.

From Station B, three three-phase circuits of No. 1 double-braided weather-proof wires are continued, closely following the banks of the Willamette River, over a very substantial pole line to the sub-station in Portland, 14.3 miles distant. The line is supported on two-bell insulators, having an outside diameter of three and one-third inches, which in turn are supported on locust pins placed twelve inches apart. The loss of voltage over these circuits at full load is eleven per cent.

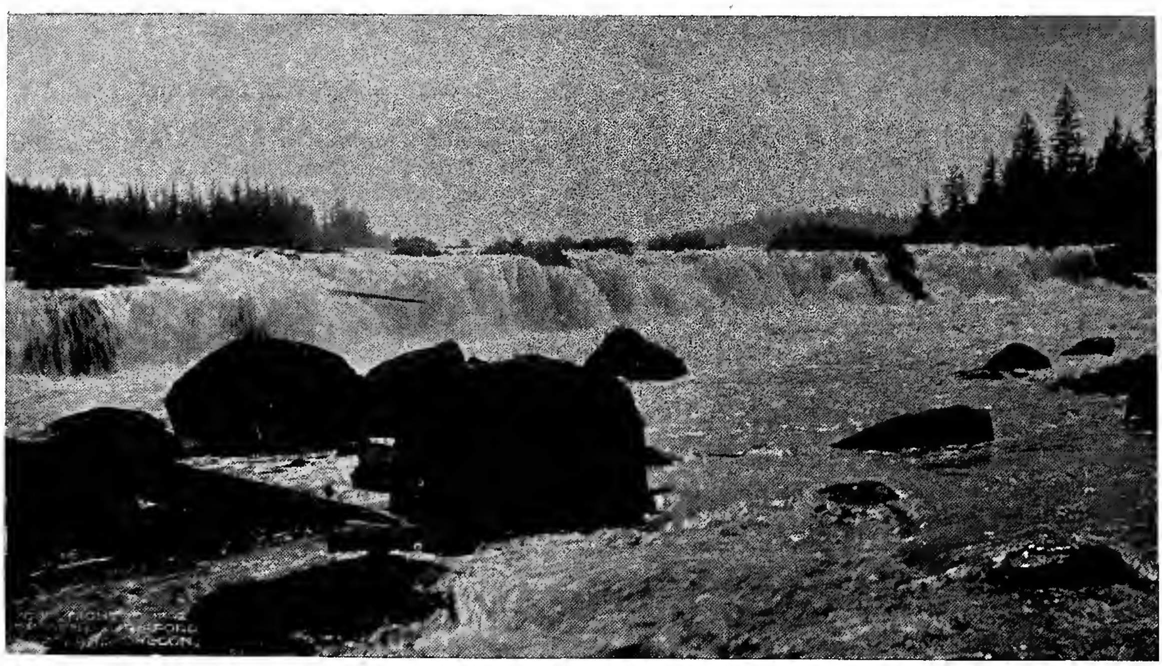


FIGURE 1—*The Falls of the Willamette River at Oregon City, Oregon.*

The particular feature of interest centering in the substation at Portland and which has not been heretofore described, is the scheme of distribution for lighting and power circuits. The three-phase current reaches the sub-station at an E.M.F. of approximately 5,500 volts, and is conducted direct to the transformer chambers, where it is fed to three banks of air-blast transformers, shown in the accompanying illustration. As will be seen in Figure 6, each bank of these step-down transformers is arranged in three sets of five transformers each, there being therefore fifteen forty-KW. transformers to each bank, and each bank being operated by a separate dynamo. The first of the banks is used for incandescent lighting direct, and its transformers are wired with the primaries in series across two wires of the three-phase circuit, while its secondaries are coupled in parallel, delivering a simple single-phase current at 133 volts to three circuits on a four-wire system.

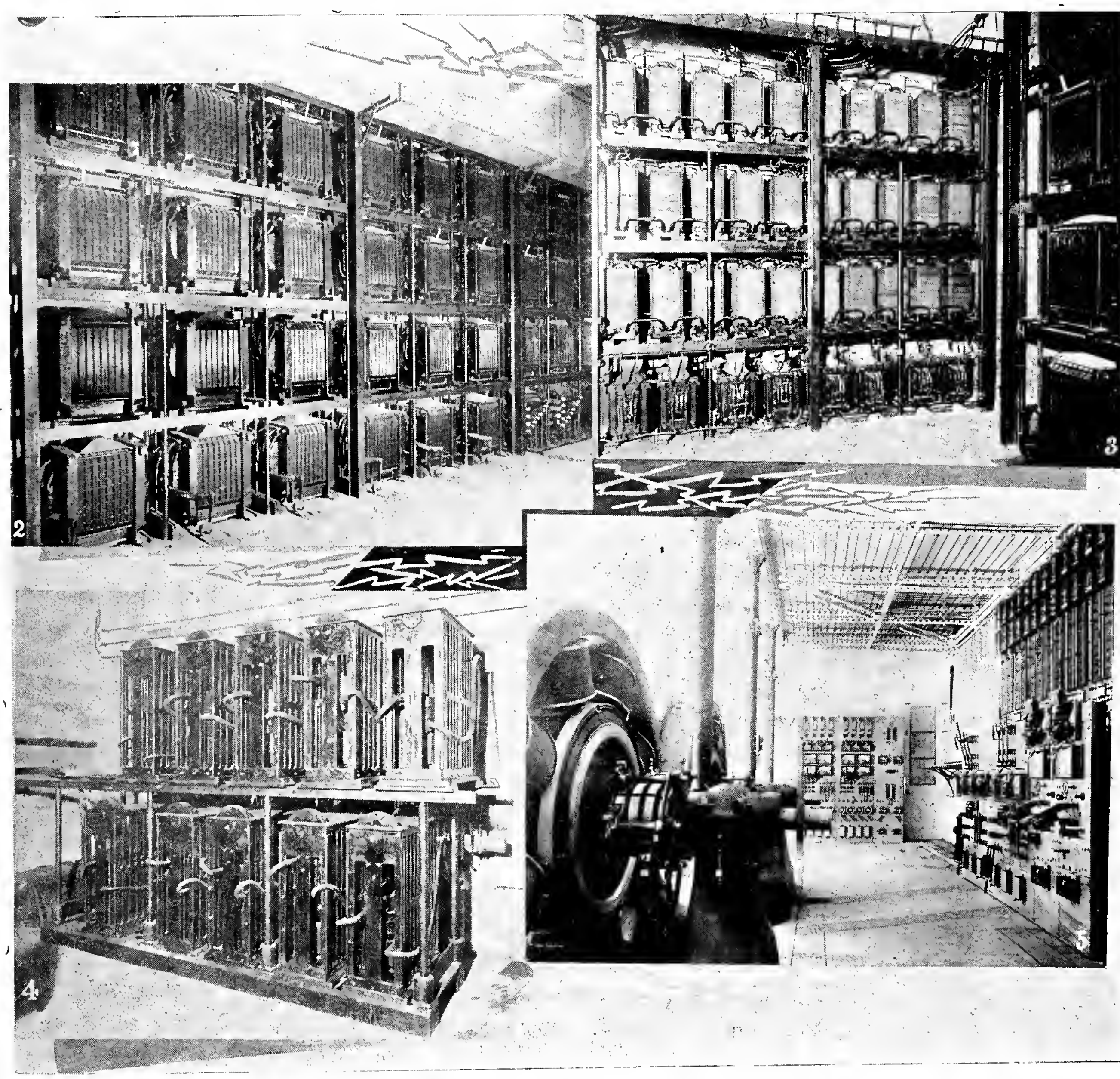
The second bank of transformers follows the same connections as to transformer couplings as in the last

instance, with the single exception that the output of the bank at an e. m. f. of 350 volts, which is applied to the operation of the rotary transformers shown in the accompanying illustration. These motor-generators are each of a capacity of 400-kilowatts, and run at a speed of 500 revolutions per minute. They are over-compounded 10 per cent., and deliver an e. m. f. of 500 volts at no load. The direct current thus realized is utilized for electric railway and power purposes.

In the last transformer bank, the primaries of each transformer are each wound for 1,100 volts as in the previous instances, and then coupled in series across two wires of the three-phase circuit, and the secondaries of the transformers, each being wound for 408 volts, are connected in series which deliver a single-phase alternating current at a potential of 2,040 volts, through the switchboard shown in Figure 5, which controls the residence and outlaying districts of the city.

The first feature to attract attention is that of operating incandescent lamps at the very low periodicity of thirty-three cycles per second, and which is here demonstrated to be practicable, as the satisfactory burning of about 1,000 lamps in the immediate vicinity of the station attests, as no pulsation in the light from the low periodicity is visible. The method of controlling this incandescent service is set forth in the outline drawing (Figure 7), which will be self-explanatory when it is stated that regulation is effected through the use of the potential regulators T, T, T, T, which may be made of either polarity by means of the pole-changing switches s, and then thrown direct into the main circuit either as step-up or step-down transformers, after the manner originally practiced in the Stillwell regulator. The switchboard, which is wired as here outlined, is that shown in the rear in Figure 5, and although a very marked economy in wiring results from this type of four-wire distribution (the circuits being figured at six sixteen C.P. 3.6-watt lamps per ampere), yet the system cannot be considered as entirely satisfactory, owing to its extreme sensitiveness of balance, and it is not probable that the company will extend the installation first made.

The 2,040-volt panel of the lighting switchboard, therefore, gives evidence of experimenting that has not



FIGURES 2, 3, 4 AND 5—*The Air Blast and Westinghouse Transformers; the Potential Regulators and the Rotary Transformer and Switchboard Room at the Sub-station, respectively, of the Portland Transmission Plant.*

as yet been prosecuted to a successful issue. As appears further on, the entire City of Portland was lighted by Westinghouse high-frequency apparatus before the installation of the three-phase system, and the scheme outlined in Figure 7 was designed and installed for the purpose of displacing the use of the old apparatus by delivering a single-phase primary potential of suitable voltage, derived from the three-phase system, to the existing lines, but it was soon found that the carrying out of the plan proposed would necessitate throwing out the well-tried and reliable house transformers which had been in long service and the replacing of them with new apparatus, because of the low frequency of the three-phase plant. This involved unnecessary expenditures which the company was not prepared to make, and as the result, at the time of the writer's recent visit to the plant, the 2,040-volt panel was not in use, and it was thought that it would undoubtedly remain a dummy for an indefinite period.

The lighting of the outlaying districts is at present accomplished through the use of the Westinghouse transformers shown in the accompanying group of illustrations, which are supplied with high-frequency current generated by the Westinghouse machines in station A of the company at Oregon City, and which are about to be described, the only difference from the original installation being that, while the primary incandescent circuits in West Portland are run at 1,000 volts as originally

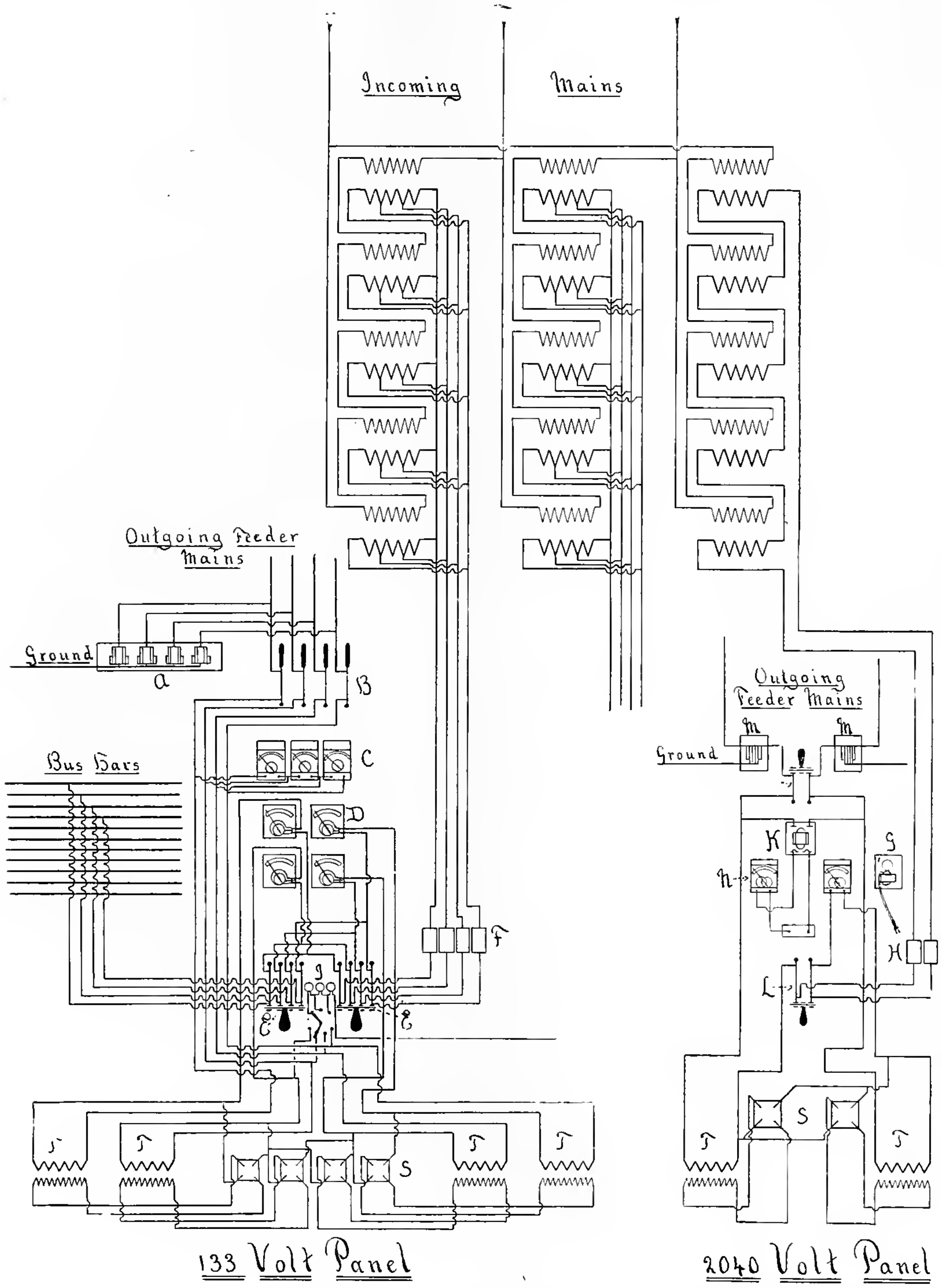


FIGURE 6—CIRCUITS OF THE THREE-PHASE LIGHTING SWITCHBOARD OF THE PORTLAND TRANSMISSION. *A, Lightning Arresters; B, Main Line Switches; C, Voltmeters; D, Ampere-meters; E, Transformer Switches; F, Fuse Blocks; G, Ground Detector; H, Circuit Breaker; I, Lamp Indicator; K, Voltmeter Transformer; L, Transformer Switch; M, Ground-Detector Transformer; N, Voltmeters; S, Pole-changing Switches; T, Potential Regulators.*

installed, those in East Portland are run at a potential of 2,000 volts. The original plant of the company is known as Station A, and is located on the east side of the Willamette River at Oregon City, almost directly opposite the falls and at the steamboat basin. Its electrical equipment consists of eight 1,500 light Westinghouse toothed armature incandescent A.C. dynamos, running at 16,000 A.P.M.; two 120-KW. Thomson-Houston incandescent A.C. dynamos; eleven 100-light Excelsior arc lighting dynamos; one Edison 120-volt D.C. dynamo, used as an exciter for the alternators and for operating the station incandescent lights; one 450-light 120-volt Edison dynamo used as exciter shift; two sixty-KW. and one 100-KW. Edison railway generators and one sixty-five-light Brush arc dynamo, together with two Westinghouse exciters driven by an independent water wheel. The hydraulic equipment in Station A consists of seven 300 H.P. thirty-five-inch Victor vertical turbines, one 250-H.P. thirty-inch Victor horizontal turbine, one 600-H.P. forty-two-inch Victor vertical turbine and one special seventy-five-H.P. fifteen-inch Victor vertical turbine for driving the exciter.

Station A carries the main incandescent load and the entire arc-lighting load of the city, and an interesting feature of municipal lighting is the fact that, in addition to the 600 arc lamps used at street intersections, the darkest streets and those containing thick shade trees are illuminated by twenty-five-C.P. incandescent lamps, 750 of which are utilized, being operated from one 1,500-light Westinghouse alternator.

The Westinghouse installation described in Station A constitutes one of the pioneer lighting transmission plants, and it is yet in such perfectly satisfactory condition that in the marked extensions being made by the company no alterations therein are contemplated. The generators deliver current to the line at a potential of 4,000 volts, which is carried over sixteen miles of double-braided weather-proof wire to the sub-stations at Portland and East Portland, where it is reduced by means of the Westinghouse transformers previously referred to. The two Thomson-Houston alternators in Station A deliver current to banks of step-up transformers for the transmission circuits, the potential being thereby increased from 1,000 volts at the generator to 5,000 volts for transmission. These banks of step-up transformers each consist of series of five converters wound in the ratio of one to one, the primaries being thrown in parallel across the generator, and the secondaries being coupled in a multiple series.

A pole line is run down on each side of the river to the City of Portland, and for the arc circuits four trunk lines and one spare circuit is carried down on the east side from Station A for lighting East Portland, and six arc lines are carried down the west side for lighting West Portland. These circuits are of No. 4 B. & S. gauge double-braided weather-proof wire, the most interesting line being a single No. 4 circuit, almost exactly seventy miles in length and on which are burned ninety-eight 2,000-C.P. arc lamps. This extraordinary circuit is operated from a 100-light Excelsior dynamo, which carries a load of 108 lamps, the line resistance equaling ten lamps. Two hundred arc lamps have been burned experimentally for several consecutive evenings in Portland on a single circuit, operated at over 10,000 volts by two of these Excelsior dynamos in series.

The east-side pole line contains no features of particular interest, but the west-side line, which was rebuilt in September last, contains a conglomeration of circuits that make it noteworthy. It consists of fifty-foot poles, having a diameter of twelve inches at the top and varying in diameter from twenty inches to twenty-four inches at the butt, the poles being placed 100 feet apart. The poles erected in the country division contain three six-pin crossarms and three eight-pin crossarms, giving, therefore, a total of forty-two pins, and on these are run the following circuits :

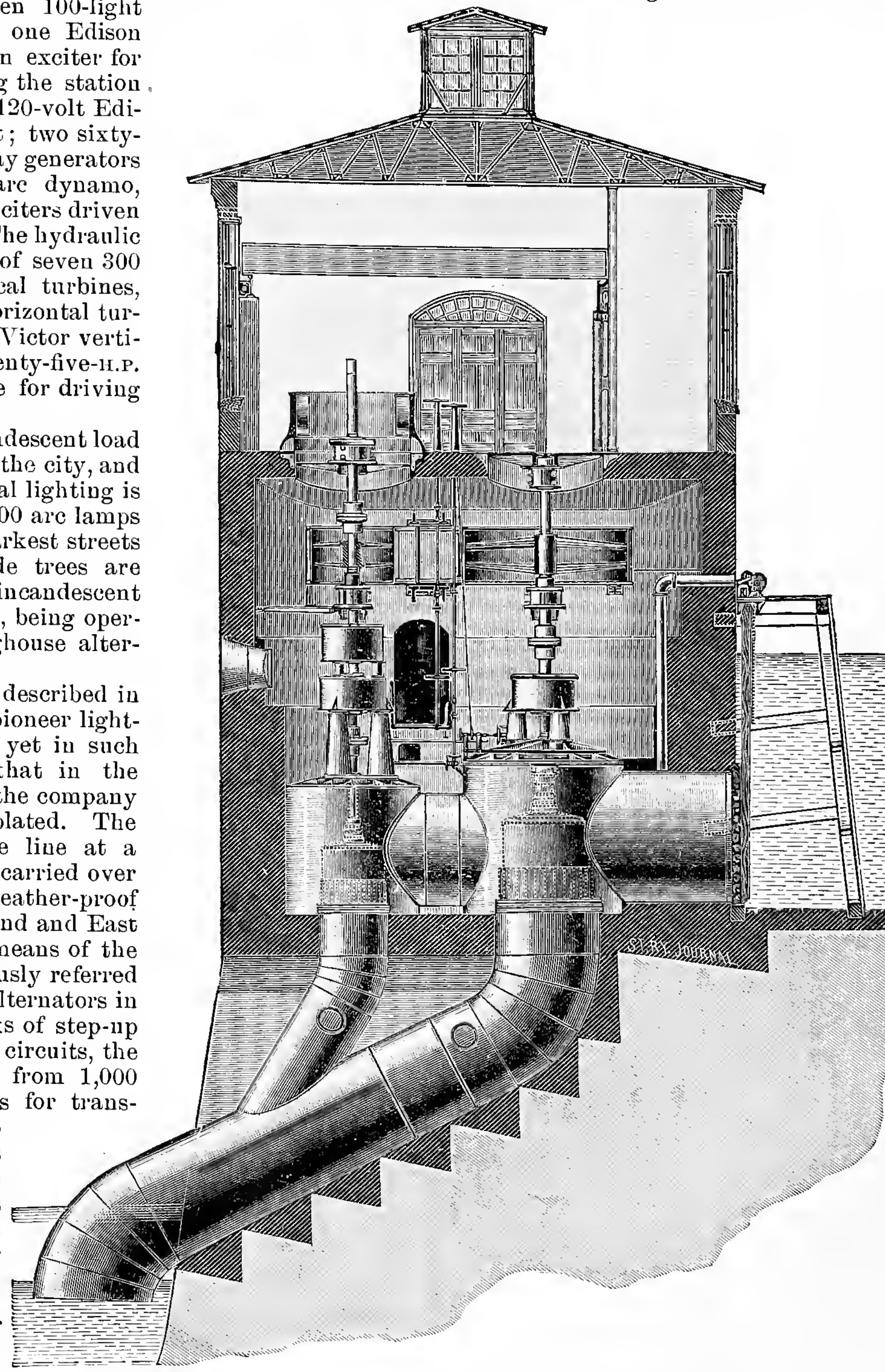


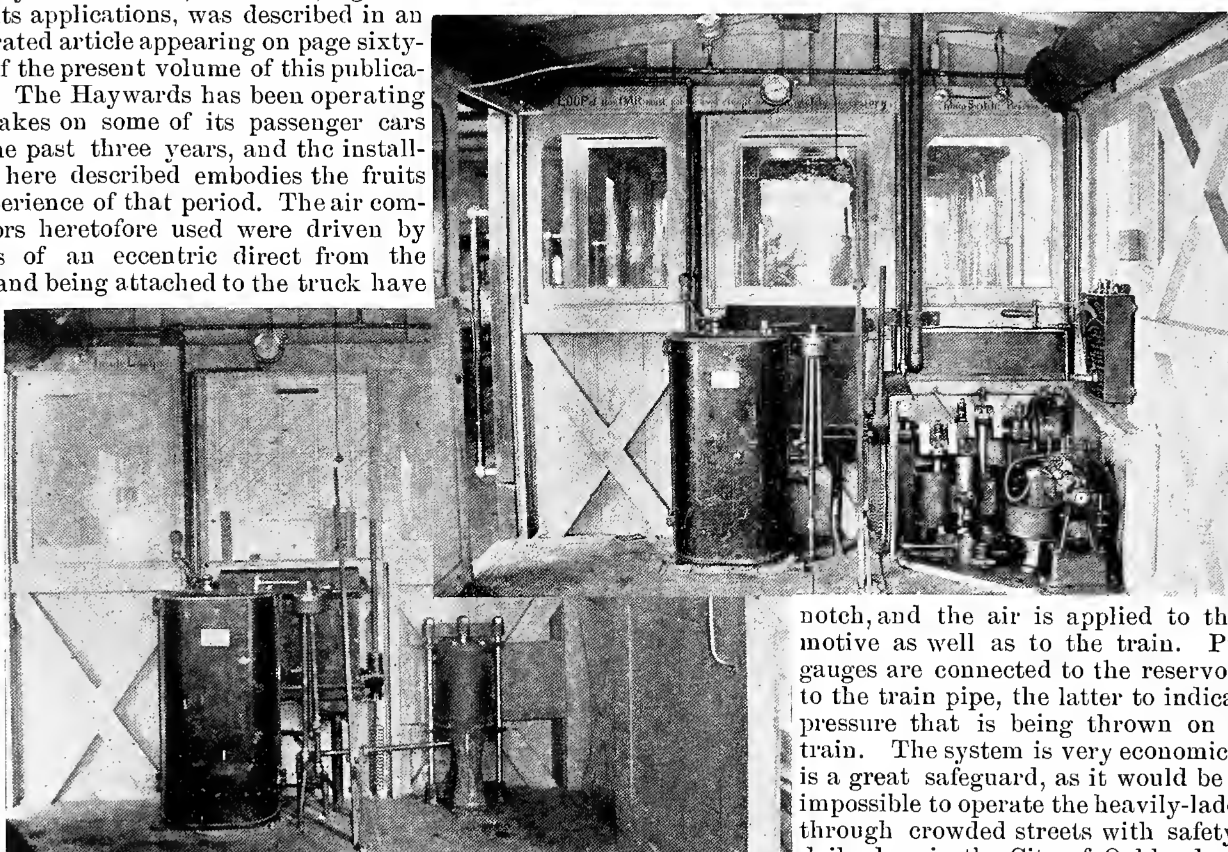
FIGURE 7—*Sectional View of Station B, of the Portland Transmission Plant.*

Seven 4,000-volt incandescent circuits No. 4 wire; six arc circuits of No. 4 wire; two three-phase circuits of No. 1 wire; one six-conductor Okonite telephone cable; one galvanized iron linemen's call-bell circuit; one copper signal circuit, a total of thirty-six wires.

Communication between the attendants at the substation and at the generating station is effected by means of signals rung in on vibrating bells. In addition telephonic communication is carried on with ease over the cable above referred to, which, as stated, is strung along the transmission line. Considerable interesting experience has been derived in this installation in connection with telephoning over lines submitted to heavy induction, and which will be fully described in an early issue of this publication.

AIR BRAKES ON THE HAYWARDS LINE.

The accompanying illustrations present views of the interior of the electric locomotive in use on the main line of the Oakland, San Leandro and Haywards Electric Railway Consolidated, and which, together with its applications, was described in an illustrated article appearing on page sixty-nine of the present volume of this publication. The Haywards has been operating air brakes on some of its passenger cars for the past three years, and the installation here described embodies the fruits of experience of that period. The air compressors heretofore used were driven by means of an eccentric direct from the axle, and being attached to the truck have never given satisfaction, because of the exposure of the working parts and of the dust and the dirt that is constantly being set in motion by the moving of the car. It became apparent during the construction of this electric locomotive that air brakes would be necessary to the handling of the heavily laden flat and coal cars, and, accordingly, Mr. C. Gustafson, then Master Mechanic but now General Manager of the road, designed and installed the air brake plant described.



Air Brakes on the Haywards Line.

The pump consists of duplex single-acting cylinders having a diameter of five and three-quarter inches by five-inch stroke, which is connected with a crank shaft driven in turn by a two-horse-power 500-volt motor as shown in the illustration. This motor, which was built by the Electrical Engineering Co. of San Francisco, runs at 2250 revolutions per minute, and is connected to the crank shaft by a worm gear, which reduces the speed of the pump to forty revolutions per minute. The equipment is mounted on a single baseplate, and is of such mechanical construction that there is nothing about it to get out of order. The plant has been in constant use for the past eight months, during which time it has given perfect satisfaction, and it is no venture to express the belief that it will run for years without expense other than that for oil and brushes.

The air reservoirs are placed inside of the locomotive under the ceiling, and are of wrought iron piping having a diameter of two feet eight inches, and being fourteen feet long. The air pressure is carried at about forty pounds. The jam cylinders are also placed in the car as shown in the cut, and, in addition to the locomotive, all flat and coal cars are equipped with jam cylinders. The controller valve is so constructed as to apply the air to the train first. In ordinary stops this is quite sufficient, but, if a very quick stop is necessary, the motor-man simply throws the lever to the next notch, and the air is applied to the locomotive as well as to the train. Pressure gauges are connected to the reservoirs and to the train pipe, the latter to indicate the pressure that is being thrown on to the train. The system is very economical, and is a great safeguard, as it would be almost impossible to operate the heavily-laden cars through crowded streets with safety, as is daily done in the City of Oakland, without an equipment such as here described.

ELECTRICITY FOR GRAIN HAULAGE.

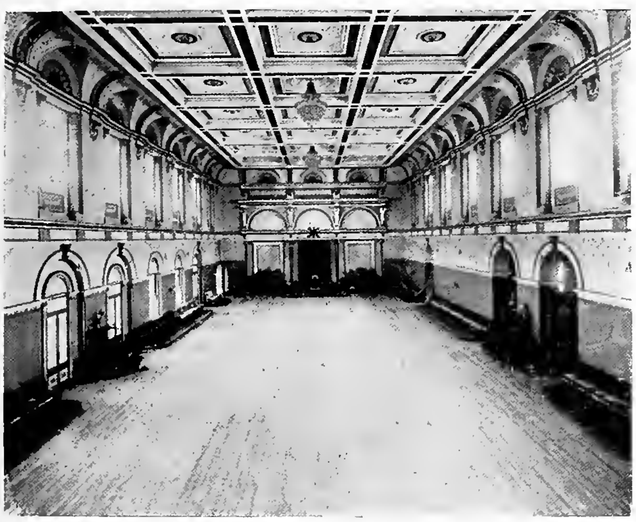
An electric freight car operated by the ordinary overhead trolley system is being operated in Spokane, Wash., by the "C. & C." Flouring Mills, owned by the Washington Water Power Co., and which have recently been leased to the Portland (Or.) Flouring Mills Co. This freight or grain car, which runs regularly between the "C. & C." mills and the railway station, displacing the drays formerly used, was specially built for the service. It is twenty feet long, and the grain compartment is twelve feet long, six feet wide and five feet six inches high, with a capacity of 12,000 pounds, or 200 bushels of wheat. At the freight station, the floor, which is hinged and carries a steel hopper, is raised, and the car is loaded

with grain from the main line cars. On reaching the mill the car is run over a chute, the gate of the hopper is opened, and the grain is dumped. The floor is then let down to cover the hopper, and the car is loaded with bags or barrels of flour to go to the railway station. Whenever the streets along the line require macadamizing, the car is used for carrying and discharging the broken stone.

PHOTOGRAPHY BY GLOW LAMPS.

By W. Lodian.

I have chanced to see in this far-off country a copy of The Journal of Electricity for October, containing the excellent and beautifully illustrated article by Messrs. Mullander & Sprout on "Night Photography by the Electric Light," which recalls the fact that among the writer's batch of electrical curios, collected during a recent six months' tour through Australasia, is the accompanying photograph of the largest private ball-room in the State of Melburnia. The view, which was taken by Theodore O'Shea, a leading photographer of Melbourne, and presented to the writer, is interesting in that it is



Photography by Glow Lamps.

the first one taken by the aid of incandescent lighting exclusively in the southern hemisphere. Considering the circumstances, the picture has turned out to be first-class in every regard.

It was a moonlight night, and the view was taken a short time prior to the opening of a ball. An exposure of twenty minutes was given, a four by five plate being used. The cleverness of the photographic printer came in in so retouching the negative as to remove the blurred appearance surrounding each incandescent light. So neatly was this done that, when the present photograph was placed side by side with a daylight taken photograph in the recent photographic exposition at Melbourne, the difference between the two could not be detected. In truth, the picture is a remarkable example of electrical photography, as no magnesium light or illuminant other than the glow lamps in the room was used.

Calcutta, India.

THE A. I. E. E. IN SAN FRANCISCO.

The first meeting for the winter of the Pacific Coast members of the American Institute of Electrical Engineers was called on Saturday night, November 30th, at the request of the secretary of the institute, in order to combine with the meetings in New York and Chicago for the topical discussions on the present status of the storage battery question. This meeting is notable as being the first held on the Pacific Coast with regular officials of the institute in attendance, the recently elected vice-president being in the chair, and the local secretary officiating as secretary of the meeting.

After a pleasant dinner at Frank's rotisserie, where, in addition to the regular members, such prominent guests as Professor Davidson of the Coast Survey, W. S. Hager of the Westinghouse Company, and W. C. Swain, chief operator of the Postal Telegraph Company, were in attendance, the business meeting was called to order and the principal speaker, Mr. E. J. Molera, was introduced. After a review of the early history of the storage battery invention, Mr. Molera proceeded to give an account of his own early experiments in storage battery manufacture and accumulator traction, exhibiting the first Plante storage battery cell imported into this country, together with a cell and switches from the first accumulator car ever run, which had been operated by Mr. Molera in the City of San Francisco in the year 1882. After this important communication from Mr. Molera had been received, the local secretary gave extracts from the papers presented before the institute in New York by Professor Carhart and Mr. Arthur E. Childs, and then showed to the members load curves obtained from the San Jose Street Railroad and the Electric Light Company of the same city, indicating the greater importance of the storage battery in the average street railroad station than in a similar lighting supply station. Following this communication Mr. Hager explained to the members the investigations he had made on the applicability of the storage battery supplying power for the electric railroad system of the City of Wilmington, Del., and stated in conclusion that he considered, even with the present high cost for accumulators, that they were undoubtedly the cheapest means for supplementing the generating apparatus on any electric railroad, provided that the batteries were installed for the purpose of carrying simply the peaks of the curve and being operated at the time of their maximum load considerably above their rated capacity, which, in Mr. Hager's opinion, was a justifiable use of well-made storage batteries, an opinion derived from an extensive investigation of well established plants.

At the conclusion of this communication the meeting was adjourned after the appointing of an Executive Committee, consisting of E. J. Molera, F. F. Barbour and Professor Clarence L. Cory, with instructions to confer with the local secretary and formulate a plan for continuing the meetings throughout the winter.

PERSONAL.

Mr. Frank X. Cicott, Manager of Billings & Spencer, of Hartford, Conn., has been traveling over the coast in the interests of his firm.

Mr. C. S. Knight has returned East after having established a Pacific Coast office of the Fort Wayne Electric Corporation in San Francisco.

Mr. O. S. Lyford, Jr., Chief Engineer of the Siemens-Halske Electric Compamy of America, has gone back to Chicago, but is expected to return to San Francisco shortly.

Mr. H. S. Clark, of the Westinghouse Electric and Manufacturing Co., has been ordered from the San Francisco office to Pittsburg, where he will engage in special testing work at the factory.

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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A PLEA FOR MOTORMEM.

In the "Electrical Engineer" for November 13th we note an article signed "A. F. D." on "A Plea for Motormen," which is recommended to the careful consideration of every electric railroad manager. In this article the author calls attention to the fact that, while honesty and integrity are undoubtedly necessary requirements for a satisfactory motorman, an amount of electrical knowledge beyond that possessed would increase his efficiency as a handler of the electrical machinery placed in his charge.

One of the papers before the Montreal Convention impresses this in citing a test made upon an electric railroad by taking wattmeter readings when the car was run by a first-class motorman, and afterwards run by an electrical engineer understanding the principles of the controller. The difference in the total amount of power employed amounted to as much as twenty per cent. in favor of the engineer. In many cases it is not possible for street railroads to maintain a school for the instruction of their employees, but it is always possible for the street railroad to employ the motormen upon the waiting list as repairers and helpers in the car shed. In this department they would unfailingly gain an acquaintance with the construction of the motors, method of wiring cars, and the principles of the controller which would enable them to understand the importance of the rules issued to them for instructions in operation. Such a course of instruction would raise the tone of the men at the brake handle by making them feel themselves more nearly upon the level of the locomotive engineer. The article we are discussing mentions the fact that, in steam railroads, managers have found that it pays to post in their roundhouses honor rolls showing the record in running and the consumption of material of each engineer; but though the electric railroad motorman can materially alter the consumption of coal at the central station by his handling of the controller lever, no attempt is made to distinguish between careful and intelligent workmen and those who simply carry their car over the line without regard to the apparatus on the car or the amount of power used. With the introduction of high speed working in electric tram lines has come the liability of accidents from obstructions on the track, which can only be diminished by a corresponding education of the motorman, and a rise in his character as a workman, which will undoubtedly come about whenever the managers appreciate the fact that his efficiency will be increased through careful instruction.

AIR TRANSMISSION AT HIGH PRESSURES.

It is gratifying to learn that the experiments made at the Presidio upon the Rix compressed air apparatus built by the Fulton Engineering Works have proved to be eminently successful, and the fact that there is in this country an engineer capable of designing efficient compressed air apparatus will do more to advance this system of power transmission than the experience derived from the low pressure systems which have been installed in Paris and in England. The distribution of power by the means of compressed air was suggested to the promoters of the Niagara Power Company, but at the time the only system of compressed air distribution sufficiently extensive for comparison was that of Popp, in Paris, which uses a maximum pressure of 200 pounds and distributes at a maximum distance of 10 miles through large mains running up to 30 inches in diameter. While the transmission losses are undoubtedly small in this distribution, still the leakage is great enough to reduce the efficiency of the entire system to about 38%. Using higher pressures up to 2000 pounds, which Mr. Rix's apparatus has demonstrated to be practicable, General Hermann Haupt estimates that 2,500 horse-power may be transmitted one hundred miles with an initial cost of plant below $750,000, and a total yearly cost for power delivered not greatly in excess of $13.00 per horse-power. At the present time there are too many problems remaining unsolved connected with power distribution through the medium of air, at 2000 pounds, for any one to be able to state whether these figures are entirely accurate or not, but we have here already solved the problem of initial compression, and we may expect this achievement to be followed step by step by solutions of the various transmission problems and other problems connected with high pressure air distribution. Surely the engineering successes attained will not be allowed to remain much longer unused, in the face of the great long distance power transmissions now constantly being brought up for solution.

ELECTRICITY IN OFFICE PRACTICE.

Before the Fresno County Medical Society, Dr. W. N. Sherman, of Merced, Cal., has recently presented an extremely interesting paper upon the subject of "Electricity in Office Practice." The advance of electro-therapeutics has, during many past years, been greatly hindered by charlatans and quacks who have seized upon the mystical character of electric action in order to dupe their patients into the purchase of electropoises, electric belts, towels and hundreds of similar impositions. During all this time, however, certain conscientious doctors have labored

earnestly to understand the action of electricity upon the human body, and, with the aid of apparatus designed by D'Arsonval and Charcot, in France, and by Kennelly and Morton in this country, their investigations have proved that not only does the application of electricity itself have certain distinct effects upon the muscles, tissues and nerves, but also by the means of electricity well-known medicines may be introduced into the system in such a manner as to effect a maximum amount of benefit. The latter application, while newer than the treatment by electric shocks and baths, appeals more to the intelligent electrician. Not only is electric cautery produced by incandescent platinum wires, but also by the local formation of caustics through the medium of electrolysis decomposing the salt solutions contained within the body itself. Using soluble anodes, the physicians have been enabled to apply the highly antiseptic hydrochlorites of copper, zinc and iron directly to the tenderest mucous membranes, and effect cures in catarrhal diseases which have heretofore obstinately evaded treatment.

By the means of cataphoresis, which is the name for osmotic transference of liquids by an electric current, it has been found possible to introduce into any point of the system many liquid medical agents, such as chloroform, quinine, iodine, etc., and to produce exceedingly effective local anæsthetic and medical actions upon the blood without disturbance of the digestive organs, which has accounted for many of the evil after effects of these curative agents.

In nervous diseases Dr. S. Weir Mitchell has been able to obtain effects similar to massage and to strengthen the tissues of a nervous patient by the means of an agent disassociated from the common repugnance to drugs and consequent mental disturbances. All of these methods for treatment have placed the science of electro-therapeutics upon a sound footing both in the minds of the members of the medical profession and of those familiar with the phenomena of electricity. At the present time in medicine the treatment of disease by the means of drugs has given place largely to surgical treatment, though the attendant injuries are often serious in such practice, and we may hope that the advance now taking place in electro-therapeutics will be able to re-introduce the earlier method and to make it more efficient than ever before.

SCHOOLS FOR ENGINEERING EDUCATION.

The enormous extension in schools throughout the world for teaching the technical professions has opened many questions concerning the conduct of such schools and the requirements for both instructors and scholars. Fifteen years ago such schools existed only for the education of civil and mechanical engineers, while the general tendency was to consider them as minor departments of the academical colleges; but at the present time we find that instruction is given in all branches of engineering knowledge, and that the students in attendance rival, in numbers at any rate, those in the academical courses. In face of the great increase in the number of students in all branches at the various seats of learning, it is difficult to decide whether this increase in the engineering schools has been due to a falling off amongst those desiring a general education or whether it has been due to the acquirement of engineering knowledge by those whose time and tastes would not permit of their attendance upon any other course. If the last is to be considered as the true explanation of the expansion of the engineering schools, it is fortunate that any course of instruction has been devised which will tempt busy men to increase their stock of theoretical knowledge; but if the graduates of engineering courses are to be considered in the future as completely educated men, there is danger that not only will the literary departments suffer, but also that the sciences will lack men furnished for their advancement. Such a danger is due rather to the conduct of the schools by the teachers than to the character of the scholars themselves. Every scholar forms much character and wit from his contact with a respected teacher, and if that teacher impresses upon him the worth of learning he will become enthusiastic for the advancement of learning; but if the teacher spends his own time and that of his scholars in the solution of problems for gaining money solely, there is little danger that the practical men of the next generation will complain that the student is less sharp and unscrupulous than the unlearned business man. In some schools the laboratories are furnished solely with a view of performing tests and for the students to become familiar with the methods applicable to the understanding of money-making problems. Some of our professors, even, are engaged and commonly employ their students as draughtsmen and designers in the manufacturing business, without regard to the value of their work when viewed as knowledge. No complaint can be made of any man who desires to keep thoroughly in touch with the practical advances of the knowledge of the world, nor should the teacher hesitate to give advice based upon his knowledge and experience to those undertaking practical problems, but when the instructor enters into manufacturing competition which necessitates for success that he should conceal from other manufacturers the most important advance he is capable of making in his profession, he encourages a system of concealment of knowledge which is unfortunately too prevalent throughout business, and which only a teacher is capable of counteracting. It seems strange, when we consider the teachers of the last generation were blamed for retiring within themselves, that the recent introduction of technical schools has changed the conditions so greatly that such a warning can be issued, but it is an unfortunate fact that some of our engineering professors are apparently aiming more at their own personal advancement than at the preparation of their students for the duties of life and a high-principled citizenship, which should be the safeguard of our civilization.

Passing Comment.

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

There is an heretofore unpublished anecdote concerning a now much discussed English professor's early visits to this country in connection with the Niagara power transmission, which may throw a sidelight upon his published acquaintance with the people of wealth and fashion upon this side of the water. We have the story from the professor's unfortunate host. On one of his visits to a city within a night's ride of New York, accompanied by his famous meter, which he was trying to sell, the professor asked some legal advice of a gentleman high in social and literary circles in the city where he was visiting, and to whom he had the usual letters of introduction from the London friends of the American. In the midst of his legal inquiries the professor incidentally mentioned that he desired to have his presence in the city unknown to the electrical and newspaper men, and, on the hint, was taken to his legal adviser's country home, where he was handsomely entertained until his business was completed. After waiting a sufficient period of time his host casually submitted a moderate bill for his legal advice to the professor, and though some year or more had elapsed at the time this story was told, nothing more had been heard from the eminent engineer, though his companion on the visit, the energy meter, was reposing in his host's strong box for safe keeping against the time when it should be sought after by all American manufacturers and distributors of electrical current.

Whether other acquaintances were made by the courteous professor, during his many visits to this country, in the same manner, is not known, though it is hardly believed that the methods used would be often indulged in by our cheeky American engineers when visiting either at home or abroad.

Of all the tributes that have been printed to the memory of the late Franklin Leonard Pope, there is no one that appeals to the mind of the engineer so greatly as the unfinished article of Mr. Pope contained in the December number of the "Engineering Magazine" on "The Distribution of Electrical Power at Niagara," an article filled with references to the various plans for power distribution which have been proposed, in which in every case the vigorous mind has passed upon the salient and important points, presenting the advantages and disadvantages attached to each of the various systems clearly and intelligently. This article from the master hand is in striking contrast with the one in the same journal calling for our criticism last month, and it is with the utmost regret that we read the portion written, and try to imagine what Mr. Pope's introduction was to bring out in his mature conclusion. In the pages written by his brother, Mr. Ralph Wainwright Pope, at the end of the article the oft repeated story is touched upon of the great fund of experience of Franklin Pope's life and the failures and successes of many water power schemes with which he was familiar, and here we are compelled to pause and wonder whether some of the great electric transmissions in which we know he took so much pride may not be adding other chapters to this history of financial rashness. With every development of cheap power and cheap power transmission, engineers have dreamed far into the future of a rehabilitated world, but always we are compelled to come back to the conclusion that no mechanical or scientific advance can be a "cure all," though each piece of work well done is worth doing, even though it but leads to better methods of solving the same problems in a large way.

During the past month, in the "Electrical World" and in many contemporary journals, descriptions have been printed of the various conduit electric railway systems used in Washington and New York. Several of the papers have taken up the cudgels in favor of such electric railroads against our familiar friend, the overhead trolley, as well as against cable transmission systems. It is even stated that the officials of the Illinois Central and other standard steam roads are awaiting the results of experiments on this underground construction before undertaking the use of electricity upon their lines. "Electricity" alone, of all the papers, is distinctly hostile to this means of construction, and if the figures of cost which "Electricity" presents approach the truth, there certainly remains much to be done before the conduit system may be considered a financial success, even, though the engineering problems may be regarded as solved. It is stated that the Lenox avenue road in New York costs for conduit construction and sudsidiary sewers as much as $175,000 per mile, and if this statement is true, the amount of power saved by electric traction can hardly compensate for the cost above even the cable system. Reports from Minneapolis and St. Paul indicate that the cost of the maintenance of underground feeders has been found to be excessive in these cities, and that the very complete underground feeding system, which was originally installed, has given place to an overhead feeding system, which certainly would lead us to suspect the success of any conduit in a similar location. The feeders in Philadelphia and Boston are now being placed underground, and if they are found to operate successfully the next step may be taken towards burying the trolley, though until it is proved that the feeders may be economically maintained in underground conduits we can hardly attempt with safety the use of a complete underground electric railroad system.

In an article in the "Electrical Engineer" of Nov. 20, James Pass writes upon the durability of porcelain as an insulator; a subject which we do not remember to have seen discussed in any American electrical paper before this time, though the English journals have devoted a good deal of attention to the subject. The pottery materials which have been used for electrical insulation are divided into two general classes. First, those in which the pottery itself is the insulator, and secondly, those in which the insulation is provided by a glaze, the last material being called stoneware and the first porcelain. Stoneware has been used for many years in European construction for line insulators, and we hear that under certain conditions the salt glaze has been reduced to sodium by electrolytic action and has been the cause of conduit explosions. This difficulty requires such special conditions that it is hardly to be taken into account in any installation, though it is unfortunately a fact that when the glaze is broken away from stoneware the biscuit is so porous in character that it will very readily absorb a large amount of moisture and cannot be relied upon as an insulation. The material more generally used throughout this country is a porcelain thoroughly vitrified throughout its entire body, glaze being applied only for appearance. We notice with regret that certain supply houses are now advertising floor tubes and switch bases made of stoneware, and we may expect that this construction will soon be charged with furnishing a new cause for mysterious fires, unless the insurance inspectors will forbid its use before such accidents take place. While porcelain is more ex-

pensive in first cost, it has the property of being moldable into any definite shape and with such accuracy that metallic pieces may be fitted to porcelain bases and made interchangeable, while the material of itself is such a perfect insulator that the presence or condition of the glaze applied will influence the protection it affords but slightly. The growing use of an inferior material demands the increased amount of information concerning the properties of porcelain, and we hope that the information published by Mr. Pass may lead to a larger general knowledge on this subject.

The too often occurrence of severe accidents from bursting fly wheels, which sometimes are of such seriousness as not only to wreck entire stations but to cause the loss of many lives, has led to a very general discussion of the subject in the engineering papers, and it seems that a successful solution of the problem may be had in the interesting wheel designed by Edw. S. Cobb, M.E., and in the air-compressor plant of the North Star Mining Company at Grass Valley, Cal. This wheel, which was fully described in the November issue, presents a radical departure from the ordinary type of fly wheel particularly in that it is a trussed wheel. It is 18 feet in diameter, and is working at the normal rate of 110 revolutions per minute, which gives it a peripheral velocity of upward of 6200 feet per minute. The wheel has, however, been driven, under test, at the peripheral speed of over 7350 feet per minute, which condition, although unusual and excessively severe, was withstood without strain. It is noteworthy, moreover, that the cost of building this wheel was some $300 less than the cost of building a similar wheel by the more familiar methods, and the fact that it is operating to perfect satisfaction under stringent conditions would seem to indicate that the mechanical world should find in it a means of eliminating one of the most potent causes for accident that add peril to the use of high speed machinery.

One does not expect a great amount of technical ability to be displayed by the editor of a daily paper, though it is surprising when an editor shows a decided lack of common sense in discussing engineering problems. Possibly the San Francisco dailies, in their blind hatred toward the Southern Pacific Company, grasp at any scheme capable of proving that the railroad managers absolutely disregard the comfort of their passengers; but when we find half a column of the editorial page devoted to the old scheme of train-lighting by the means of storage batteries charged from dynamos placed upon the car axles, one is sufficiently surprised without finding in the same article that the editor seems to allow the claim of the promoters that the power for driving the generators so attached is the same as the power formerly lost in friction at the journals of the cars. That journal friction should be decreased by placing an additional burden upon the axles is an axiomatic engineering impossibility, and one would think that the editor of so able a paper as the "Examiner" would, in the interest of his own reputation for common sense, refuse the admission of such claims, even though he was capable of disregarding the misleading effect that any such an article might have upon intending investors.

Within a short time we will have an opportunity to examine the applicability of the Boynton bicycle railway system to light haulage. It is promised that within two months work will be begun upon a line from San Mateo to Pescadero, to be constructed upon this plan and operated by electricity presumably provided by the water-power of the Pescadero Creek. This line will give access to an attractive part of the sea coast much nearer San Francisco than either Santa Cruz or Monterey, while locally it will give access to a large amount of ranch and forest land, which has hitherto been almost inaccessible on account of the heavy roads over the hills between the country lying along the Coast and the Coast Division of the Southern Pacific Company. It is stated that the Boynton system has been adopted on account of the heavy cuts, fills and grades, which would have presented engineering difficulties to the construction of a standard roadbed. In spite of the fact that the road proposed is to be very winding, and to escape most of the heavy grades, still the grades that will be encountered are sufficient to tax the engineering skill of the projectors very highly, and to give a severe test to the economy of the system.

Whatever may be our prejudices for or against this system, which provides one rail under the car and one rail over it, we read in the attempt to install such a line a clear understanding of the demand for light railroads capable of serving as feeders for the standard lines; and whether the light railroad of the future will be a standard electric tram line, the Lamb suspended cable system or the Boynton bicycle railway, there will undoubtedly be much construction of such light roads in the future with the consequent opening up to home seekers of a vast extent of territory hitherto inaccessible.

Not only the daily press, but a number of the electrical journals have been greatly concerned with the report that John Jacob Astor has invested heavily in the stock of the Keely Motor Company, fears being expressed that many investors will be induced to lose money in this scheme through the influence of so eminent a moneyed man as Mr. Astor. Supposing that the report be true of Mr. Astor's investment, the scientific investigations that from time to time have been made upon Keely's scheme should surely prove of greater weight than the opinion of this member of the Astor family, especially since the Astors have not for many years maintained a reputation for shrewdness in investments outside of the real estate line. It is true that the Keely motor has never been openly and completely investigated, but it is equally true that the effects shown by Keely have been universally judged to be no more than equivalent to those which might be obtained with compressed air. Keely's experiments at Sandy Hook with his etheric gun were a flat failure, while the construction of the apparatus, method of loading and firing the gun, and in fact all of the details of the experiments pointed to a compressed air plant. At one time when Mr. Keely was declaiming upon the immeasurable pressure exerted by his force, Captain Zalinsky modestly requested that the force be applied to smash a recently tested 80,000-pound gauge which he happened to have with him at the time, though, of course, the test was refused by Mr. Keely.

Among those who have examined this motor and have reported that there is nothing unprecedented in its action, electrical men will have confidence in both Professor Elihu Thomson and T. Carpenter Smith, not to mention other electricians of less note and clearness of mind who have reported unfavorably to the scheme. If, in face of the unfavorable scientific reports that have been made on Keely's invention and of the doubtful business methods that have been indulged in by this company, there are still to be found investors who will follow the lead of John Jacob Astor, they can only be considered in the light of the dupes of a confidence man who are only defrauded by reason of their own desire to overreach someone else.

Electro-Insurance.

THE MEETING OF THE ELECTRICAL COMMITTEE OF THE U. N. E. A.

A well-attended meeting of the Electrical Committee of the Underwriters' National Electric Association was held at the rooms of the National Board of Fire Underwriters in New York City on Tuesday, Wednesday and Thursday, December 10th, 11th and 12th.

As the work of the Electrical Committee of this Association has now become generally recognized throughout the United States by the various boards of Fire Underwriters, which have adopted the rules as recommended by the Committee, and as quite a number of cities have also incorporated, these rules in their City Ordinances regulating the introduction and maintenance of electric light and power wiring, it may be of interest to give a brief sketch of the formation of the Association and its Electrical Committee.

In the summer of 1892 the Secretary of the New England Insurance Exchange, after correspondence with the Electrical Inspectors of the Underwriters' Association in the East, called a meeting of the electrical representatives of the various Eastern Associations for August 18th at the rooms of the National Board, in New York. This meeting was called without any specially prepared plan of action, and it was not felt advisable to ask for representatives from boards situated at a distance from New York City. The meeting, however, was more of a success than was even hoped for. The rules as adopted by the National Electric Light Association were taken as a basis and carefully considered and revised, section by section. Proofs of the revised rules were sent to all the underwriters' organizations in the United States, with notice that a second meeting would be held in New York City, and with request that any suggestions in relation to the rules be sent to the chairman of the meeting. These organizations were also advised that a plan for a permanent organization of the electrical representatives of the underwriters would be presented at the meeting, and all were requested to send representatives to that meeting, which was held on December 6th of the same year.

At the December meeting a permanent organization was formed, called the "Underwriters' International Electric Association." At a later date the name was changed to "The Underwriters' National Electric Association."

The articles of association, which have only been slightly changed since their adoption at this meeting, provide, "that any member, officer or employee of any fire underwriters' organization or fire insurance company in the United States or Canada, may become a member of the association on application to the Secretary." The officers of the association are a President, Vice-President, and Secretary and Treasurer. The articles of association also provide for an Executive Committee and an Electrical Committee, the last named to consist of nine members, who shall be chosen from the electrical experts in the employ of the insurance interests. The officers are also ex-officio members of the Electrical Committee. All meetings of the association must be held at the national board rooms, in New York City. The officers and Electrical Committee, which have remained unchanged since the organization of the association, are as follows: President, C. E. Bliven, of Chicago; Vice-President, W. A. Anderson, of New York; Secretary and Treasurer, C. M. Goddard, of Boston; Electrical Committee: F. E. Cabot, of Boston, Chairman; William McDevitt, of Philadelphia; George P. Low, of San Francisco; A. E. Van Geisen, of New York; E. A. Fitzgerald, of Syracuse; Edward Leloup, of New Orleans; W. H. Merrill, Jr., of Chicago; A. M. Schoen, of Atlanta; and E. A. Braddell, of Philadelphia. At this December meeting, the rules formulated at the August meeting were again carefully gone over and amended as seemed necessary, after which every person present agreed to recommend to their respective associations that they be adopted as the standard for the territory under their jurisdiction.

The next meeting of the Electrical Committee was held on August 17th, 1893, in Chicago, and an adjourned meeting was held on September 5th, in Boston. As the rules adopted at the meeting in 1892 had then been in use by most of the principal underwriters' associations for nearly a year, the committee had the advantage of suggestions and criticisms drawn from the actual application of these rules, and they were again carefully taken up, section by section, and such changes and additions as experience seemed to indicate to be desirable, were adopted. At this meeting, also, the word "approved," which was frequently used in the first edition of the rules to describe wires and devices, was defined, and these definitions were incorporated in the rules themselves. A list of wires which had been found to comply with the requirements of the rules was also published, and a resolution was adopted calling attention to the liability of the destruction of metallic substances, especially water and gas mains, buried in the ground, by electrolysis due to the ground return of single trolley street railway systems. This resolution was sent to the various boards of underwriters to call their attention to a matter which was of practically very recent development, and correspondence was invited on the subject.

The work of Mr. Merrill, in Chicago, in connection with the Electrical Committee, is worthy of special notice. Starting first with the idea of collecting and distributing as full information as possible in regard to fires due to electricity, he has gradually established a department which is of great assistance, not only to the electrical inspectors of the country, but also to the insurance companies and their various field representatives. His fire reports, on behalf of the committee, have become well known, and have no doubt had the tendency to lessen the number of electrical fires by calling attention to the various inspectors to the probable causes which may develop an electrical hazard, as shown not simply in the experience of one man, or in one particular section, but in the experience of many inspectors, covering nearly the whole territory of the United States.

Further than this, he has established a testing bureau and a system of distributing reports of the results of the tests there made, so that every inspector has the advantage of the experience and knowledge developed by a fully equipped and well-managed testing labaratory. These reports have been of inestimable value in ridding the market of cheap and poorly constructed material and devices. The reputable manufacturers, being glad to remedy any defects shown in these reports, have improved their devices, and the goods of other less reputable parties have been, to some extent, driven from the market. It is the duty of every insurance inspector, and it is hoped that it will be the pleasure of all connected with electrical interests, to furnish Mr. Merrill with as full data as possible relating to electrical fires, and devices and materials, which may come to their attention.

The next meeting of the Electrical Committee was held in New York, on December 19, 1894. The changes in the rules made at this meeting were very few, but quite a large number of general subjects were taken up and considered and referred to special sub-committees.

The most important action taken at this meeting, however, was the adoption, with the sanction of the Committee on Lighting of the National Board, of a resolution that the members present at the meeting would urge upon their respective associations an agreement to adopt and use the rules for safe wiring, as adopted by the National Board of Fire Underwriters, on the recommendation of the Electrical Committee, and that these rules should be printed only by the National Board, and that no changes or additions should be made except as promulgated through the National Board. The adoption of this resolution, and the acceptance of the plan proposed by practically all of the underwriters' associations of the United States, at last brought about the result which was chiefly in the mind of the Secretary of the New England Insurance Exchange when the first meeting was called, that is, an absolutely uniform set of rules for electric light and power wiring throughout the United States. That this result has been accomplished, is shown by the fact that forty underwriters' associations have ordered copies of these rules printed from the same type.

The Electrical Committee, feeling that the adoption of of the rules, recommended by them, by the National Board and nearly all the underwriters' organizations, and their incorporation in the ordinances of some twelve or fifteen cities, had established the fact that their work had proved itself, so far as these rules are concerned, to be practical and satisfactory as a whole, considered that they were now in a position to invite general criticism from all those engaged in the electrical business. (The rules had previously been submitted to and approved by representatives of the most prominent electrical manufacturers and central station men.)

Early in October, 1895, the committee sent out a circular letter with blanks, practically broadcast, inviting such suggestions for changes or additions in the present rules as could be made and supported by what to the person making them seemed to be good and logical arguments for their adoption, with a statement that these suggestions would receive careful consideration at the meeting in December of that year. A very large number of suggestions were received, and this brings us to the meeting of the Electrical Committee, which has just closed its sessions this past week.

At this meeting the discussions and votes were not confined to the members of the Electrical Committee, but the full privilege of both discussion and voting were extended to all present.

Chairman Cabot opened the meeting with a short address, the recommendations in which were referred to a special committee, and on their recommendation the following resolutions were adopted:

Resolved, That any increase of voltage on interior incandescent lighting circuits would result in a corresponding increase of danger to life and property, and that, owing to the tendency toward the introduction of high voltages, it be urged that extreme care be taken by inspectors and others in charge of such installations, without which we believe serious hazards may be incurred;

Resolved, That the members of this Committee, and other Electrical Inspectors here present, pledge ourselves to exert our influence to further the enforcement of the rules and requirements of the National Board of Fire Underwriters, and to co-operate with the Electrical Bureau of said Board in furnishing that Bureau with facts that come under our observation regarding devices and materials which may not be constructed in accordance with these rules and the introduction of which would create a hazard to property.

Resolved, That we further agree that all bureau reports received setting forth such facts shall receive careful consideration, and the findings of the report be followed out as far as possible in our respective territories, to the end that co-operative work along these lines may be established and uniformity of action in all essential matters secured.

Resolved, That the introduction of trolley wires in municipal districts is inimical to the safety of the property of the inhabitants of such districts, and that because of this fact all possible precautions should be taken by the managers of trolley roads throughout the country to insure cutting the current off the wires in case of fire in abutting property; also, that trolley wires should be effectually protected against the possibility of contact between them and other conductors; also, that trolley systems should be so arranged that practically no difference of potential, due to the effects of trolley roads, should exist between subterranean pipes.

A committee consisting of Messrs. French, Goddard and Sweetland was appointed to consider and report on the question of how best to guard against the hazard due to the possibility of the breaking down of the insulation between the primary and secondary transformer coils, this subject being considered of importance, especially in view of the tendency toward extremely high voltages in long-distance transmission.

The matter of preparing rules to govern marine wiring was referred to Mr. Sweetland for a report.

The subject of protectors which should obviate the hazard due to the liability of wires, such as telegraph, telephone and similar signal wires, becoming crossed with electric light or power wires, was referred to a committee consisting of Messrs. Cabot, French and Merrill.

The above committee will report at a later date.

The Secretary was instructed to submit his proof of the revised rules, as taken from the minutes of the different members of the committee, before sending to the printer. He was also instructed, in accordance with suggestions made by several parties, that in compiling the rules the definitions be incorporated with the rules themselves instead of printed as an appendix.

It was voted that the Secretary advise all persons who sent in suggestions which were not adopted, of the reasons given by the members of the committee for their rejection.

The changes made in the rules, while they were considerable in number, were very few of them radical, and the general class of work which now receives the approval of the underwriters under the present rules will not be greatly affected. It seemed to be the general opinion of those present that the rules were working satisfactorily, both to the insurance and electrical interests, and that only such changes should be made as were necessary on account of the progress of the electrical industry itself, or where experience had shown that additions to the present rules were required.

The following are some of the more important changes made, and are given in the order of the sections amended in the present rules:

The grounding of the frames of generators may be allowed, when necessary, by written permission, this change being made on account of the introduction of direct connected and extremely large and heavy machines.

Switches for motors must hereafter plainly indicate whether the current is "on" or "off."

Rules were adopted requiring wires to be protected from mechanical injury in buildings when nesessary; high potential wires by substantial boxing, giving a reasonable air space, and low tension wires either by boxing or by an approved iron armored conduit tubing.

It was ruled that the mesh of wire netting for arc-light globes should not exceed $1\frac{1}{4}$ inches.

Switches on hanger-boards must cut out both poles of the lamp.

The use of wire smaller than No. 14, B. & S., will not hereafter be allowed, except for pendant and fixture work.

The rules as to the construction and painting or "filling" of moulding were made more explicit.

The rules for special wiring in breweries, etc., will require that joints and splices be avoided as far as possible, and that switches in damp places be mounted on porcelain knobs so as to give an air space behind them.

It will hereafter be allowable to draw strings into conduits for the purpose of pulling in the conductors, which should not be placed in the conduit until the mechanical work on the building has been completed as far as possible.

Hereafter cut-outs will not be allowed in the canopies or shells of fixtures.

Hereafter circuits must be arranged so that no group of lamps, whether on the same fixture or not, requiring a current of more than six amperes, will be allowed to be ultimately dependent upon one cut out, except that special permission may be given in writing for departure from this rule in cases of large chandeliers.

Steps were taken which will tend to improve the character of the double conductor, and hereafter, except for pendants and fixture work, a solid rubber insulation, protected by durable braid, will be required for flexible conductors.

Supports for motor ceiling fans must have an insulator interposed between them and the motor.

The electrical requirements of the standard for car barns and repair shops, as contained in the schedule now used by a number of rating organizations, are now to be incorporated in the rules.

Service switches must disconnect all of the wires entering the building — that is, on the three-wire system, all three wires must be opened by the operating switch.

The use of brass sheathed interior conduit and vulca tubing will not hereafter be approved for bushings.

The use of incandescent lamps in series circuits for decorative purposes will be allowed by special written permission when installed in a proper manner.

Rules for electric heating apparatus were adopted which will require, in addition to the general wiring being done in accordance with rules, that the switches shall plainly indicate whether the current is on or off; that the attachment of the feed wires be in plain sight; that stationary heaters be treated as stoves, and that the flexible conductor necessary for use with flat-irons and other devices of a similar nature shall have an insulation that will not be injured by heat, such as asbestos, which insulation must be protected from mechanical injury by a substantial outer braiding.

The above constitute the principal changes in the rules.

The suggestion that the table of safe-carrying capacity for wires was too near the actual limit of safety was referred to the chairman of the committee, for tests, investigation and reports.

The matter of obtaining more effective and more efficiently-constructed devices for automatic safety cut-outs was referred to the committte on tests, with request that they obtain all the information possible in relation to the proper construction of fuse blocks, length of fuses and efficiency of fuse metal, in connection with currents of various quantity and potential.

The attention of the committee was called to the fact that it was claimed by storage battery experts that these batteries were extremely subject to damage by water in case of fire.

The committee on tests were requested to report a standard for iron or steel armored conduits which should meet the approval of the committee.

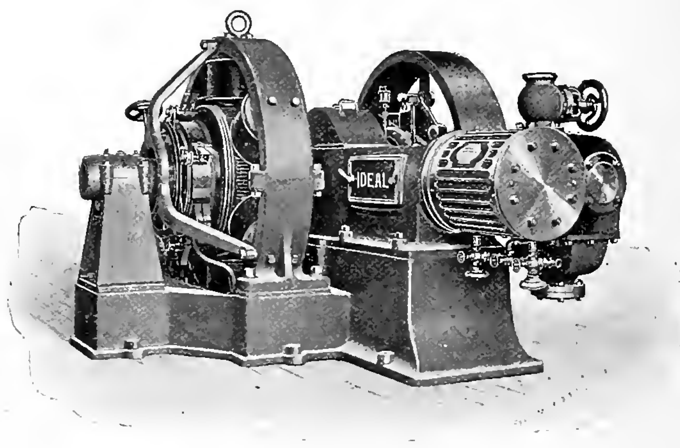
A communication from Mr. Edward H. Johnson, of the Interior Conduit and Insulation Company, setting forth the merits of that class of wiring, especially that of the iron-armored conduit, and suggesting that insurance companies should encourage this class of construction by a reduction in the premium on risks so wired, was read and placed on file.

The Trade.

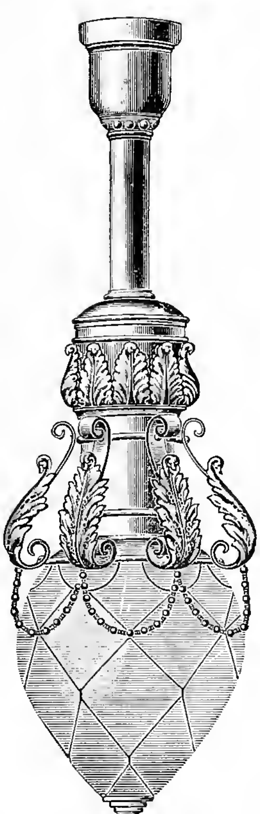
In responding to advertisements in this publication, please mention "The Journal of Electricity."

THE ABNER DOBLE COMPANY.

Of late there has been a marked tendency among old and well-established mercantile houses on the Pacific Coast to enlarge their sphere by incorporating one or



Abner Doble Co. Agents.

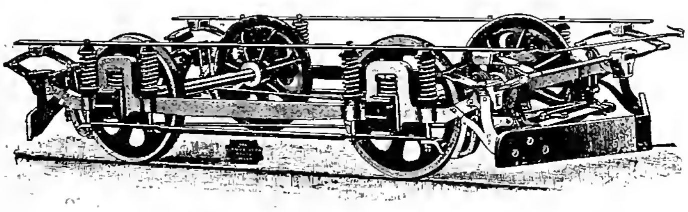


Abner Doble Co. Agents.

more branches of the electrical industry into their business, and particularly has this been the case in instances where electrical applications have formed almost indispensible links, or very important factors in their present industries. The Abner Doble Company of San Francisco is pre-eminently conspicuous among such houses. Its years of experience have placed its name among those of the most solid and best-known concerns on the coast, and it may be said that hardly a transaction occurs involving the placing of orders for iron and steel, or the erection of steam, hydraulic, pneumatic or mining equipments, without having connected with it, directly or indirectly, the name of the company referred to.

That its aims to keep abreast of the times are fully accomplished, is attested in the fact that this well-known concern has embarked in the electrical business to an extent as great, if not far greater, than has any other strictly non-electrical company. Foremost among the Eastern concerns which have entrusted the management of their Pacific Coast business to the Doble Company, is the Walker Manufacturing Company, of Cleveland, Ohio, whose high grade electric railway equipments and general electric lighting and power apparatus have at once taken rank with those of the great electrical manufacturing companies, because of general excellence in materials and workmanship. Though it has been in the electrical business but a comparatively short time, the Doble Company has succeeded in placing two large Walker railway generators in California, one of 400-KW.

in Oakland, and one of 800-KW. in Los Angeles, the latter forming the largest single generater west of the Rockies. In addition, numbers of street railway equipments, incorporating the novel and essential features of spring-mounted construction, have been sold, the most



Abner Doble Co. Agents

noteworthy order being that of the Sutro Railroad Company, of San Francisco.

Prominent among the other agencies held by the Abner Doble Company are those of the Crocker-Wheeler Electric Company, whose dynamos. motors and dynamotors are standard the world over; the General Incandescent Arc Lamp Company which, as the successor of the original Bergman Company, has improved the almost unequalled facilities it possesses for manufacturing strictly first-class arc lamps for all circuits; the Dorner & Dutton agency for car trucks and accessory railway appliances; and of Billings & Spencer, the well-known manufacturers of drop-forged commutator bars and overhead materials. Chief among the other allied interests represented by the Abner Doble Company, is that of A. L. Ide & Son, of Springfield, Illinois, manufacturers of the well-known "Ideal" high-speed engine, an application of which is shown in the accompanying illustration.

A San Francisco contemporary, the "Journal of Electricity," has in its October issue some most charming pictures illustrating an article upon "Night Photography by Electric Light." Some of the effects obtained are peculiarly beautiful, and if anything could tempt one to join the already overcrowded ranks of the amateur photographers, this article and its illustrations would do it.—"Electricity," London, Eng.

J. W. BROOKS & CO.

The subject of this article is a comparatively young concern, which has within the limited period of a few brief months forged ahead to the foremost rank among the electrical supply houses of the Pacific Coast. It was established last summer by Mr. Brooks, in the belief that the Far West offered a choice field for the handling of selected agencies for electrical specialties, and originally made a specialty of street-railway materials of all descriptions, but owing to the repeated calls for other goods in varied lines, the house of J. W. Brooks & Co. has been extended from time to time, until its agency handles supplies of almost all descriptions pertaining to railway, lighting and power purposes. From the outset it has evidenced particular care in the selection of its agencies, in the promptness of shipment, in the protection of its credit, etc., until now its business has been built up so that its rating is very satisfactory.

To detail the specialties of the enterprise is obviously impossible, except in a general way, but by way of illustration may be mentioned that of the Card Electric Motor and Dynamo Company of Cincinnati, whose dynamo-electric equipments, including motors, generators and motor-generators for direct currents are made in all

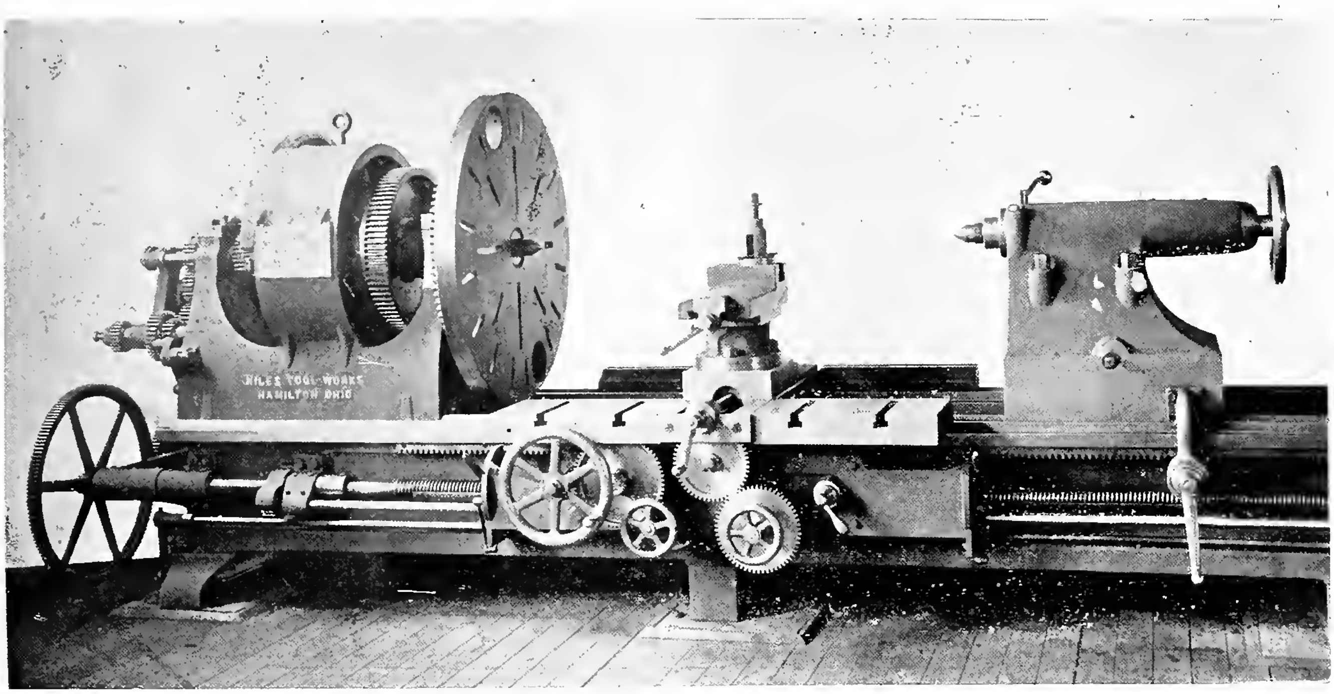


FIGURE 1—*A Card Motor, direct connected to a Niles forty-six-inch Lathe.*

types and all sizes. These machines are of the highest efficiency, and no expense has been spared in either the material or labor. They have sight-fed oil glasses, self-oiling and self-aligning bearings, steel pole pieces, laminated armature, etc., etc. The prices given include insulating base, belt tighteners, pulley, rheostat, main switch and boxing, and all machines are guaranteed against any electrical or mechanical defect, for one year after date of sale.

A feature of electrical development that will commend itself to general machine-shop interests, and which has been made a specialty by the Card Company, is the direct application of electric motors to all kinds of power machinery, such as lathes, drills. planers and printing presses. One such application is illustrated herewith, showing a Card electric slow-speed motor mounted on and direct connected to a Niles forty-six-inch lathe. The advantages accruing from such con-

struction are manifold, as it eliminates the use of belting, loose pulleys, etc., and enablds a shop to be driven with less than fifty per cent. of power than would be necessary in the use of long lines of counter shafting with belts and speed-changing gear. Another application of Card apparatus that has received great attention is the manufacture of direct-connected dynamos, a small installation of which is shown in Figure 2.

Other noteworthy agencies are held by J. W. Brooks & Co., among which is that of the Mica Insulator Company of New York, manufacturers of the well-known "Micanite," so universally used in street railway and general electrical construction. A single reference will show the desirability of using micanite. A recent number of the London "Electrical Engineer," in describing the gigantic de Ferranti alternator recently erected in the Deptford station, thus alludes to the construction of its thirty-five-ton armature:

"The smaller end of it is solid brass, burnt on to the strips; and to this is connected the inner end of the bare copper conductor. The segment is then wound with the conductor, which has corrugation to prevent side displacement, and the adjacent turns are insulated. The insulation between the carrier and the coils is effected with micanite shields. The field coils on this de Ferranti alternator are constructed by winding bare copper strips on edge into a spiral, with insulation between adjacent turns. The carriers consist of two heavy brass castings clamped on to the segments. The danger of the high voltage from the bare copper of the armature sparking across to the field has been overcome, in this case, by placing micanite caps over the poles. These caps, which are about one-eighth inch thick, have all been tested up to 25,000 volts. Since being in use, no faults have developed in them."

J. W. Brooks & Co. also handle the Boudreaux dynamo brush west of the Rockies, the brush which, when once introduced to the station manager, is sure to find a good friend in him, for it requires no attention, running, as it does, without sparking, cutting or the necessity for lubrication. "Universal Lamps," too, have become extensively used on the Coast through the exertions of this enterprising firm; and in this connection it is interesting to note the sale of over 25,000 Universal lamps in Oregon and Washington, between November 15th and December 10th. The San Francisco Savings Union operates an isolated storage-battery plant in its building in San Francisco, and as in such installations the fluctuations in voltage are reduced to a minimum, the conditions are favorable to the use of the highest efficiency lamps attainable; accordingly Universal lamps, consuming but $2\frac{1}{2}$ watts per c. p., are used on its 120-volt circuit, thus making the current consumption of the lamp to be but .35 of an ampere. A further innovation is that of the Universal decoration lamp, consisting of a porcelain base about six inches long, on the top of which is a small ground glass globe, containing the lamp itself, thus forming an accurate representation of a burning candle.

In brief, no further proof of the growing popularity and prosperity of the firm of J. W. Brooks & Co. could be offered than a statement of the fact its business has so increased during the past few months as to necessitate its removal from the present office, at 120 Sutter street, San Francisco, to 523 Mission street, where it has leased the ground floor and basement, and which will be occupied on and after January 1st, 1896.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

In 1886 there were seven horse railroad companies in Oakland, operating eight or ten lines. In that year the first cable road was built, superseding one of the horse-car roads. There was then no other change until about 1890, when another cable road was constructed, and also the first electric railroad. Monday night the last horse-car line was abandoned and the last horse-car turned into the stable to come out no more. The two cable roads are being turned into electric lines, and soon the cable cars will follow the horse cars into innocuous desuetude. The victory of electricity has been quick and complete.—Oakland (Cal.) Enquirer.

It is a doubtful proposition whether a canal company [in the endeavor to reserve exclusive privileges of developing electric light and power from the water power of its canal] can claim water that flows from the quartz mills. It is a still more dubious question, whether, even conceding its right to the water, it can exercise jurisdiction over it while passing over private lands, that will perpetuate its running to waste, under circumstances where it might, without any diminution of the supply, be made to serve a useful purpose. It is also a dubious point whether the canal company—a corporation formed for the express purpose of selling the use of the water to others—can make distinctions for or against individuals. It would seem reasonable that the company would be legally bound to sell to whoever is prepared to pay the price, so long as it has water to dispose of—that the canal company can no more refuse to sell than a railroad company or stage proprietor can refuse a passenger who applies for transportation.—Jackson (Cal.) Republican.

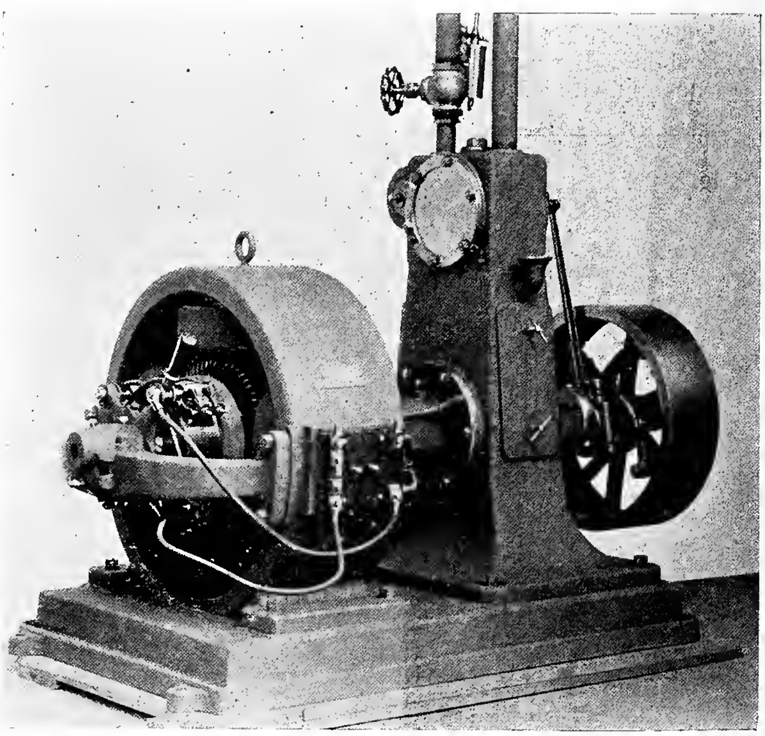


FIGURE 2—A Direct-Connected Card Dynamo.

Chas. B. Luck, of Dubuquee, Io., write: "Enclosed please find one dollar for subscription to 'The Journal of Electrity' for one year. I have received one number, and am very much pleased with it. It is newsy and not *too* theoretical, as so many of our Eastern papers are inclined to be."

A trolley wire hanging down
Essayed to paralyze the town.
Through it a fiery current ran
That ever hummed: "I want a man.
I want a man to sizzle hot,
To fry into a greasy spot—
To toast, to roast, to broil, to bake,
To singe a man I fairly ache."
Just then arrived a dairy team:
"Now here's a chance; well, I should scream!"
Thus loud the merry wire sang
And struck the nigh horse with a bang.

Down dead he fell, his mane a-scorch.
His tail ablazing like a torch;
His legs were doubled at the knees,
His smoking hoofs perfumed the breeze.
The wire hanging close the earth
Was seen to shake with inward mirth.
"I wished," it hummed, "for higher game—
Thanks for the practice just the same."

Repairers made the wire taut
And it behaved as wires ought—
Propelling cars at reckless rate,
The human race to decimate.
"Well," mused the wire, "this is fine;
Why should I murmur or repine?
Than not to kill 'tis better far
To boost along the fatal car."
Thereafter when a man was slain
The wire sang with glad refrain:
"The car is not alone," it said,
"A trolley wire's overhead;
Good people all look up and see
Grim Death's in partnership with me."
—San Francisco Examiner.

A company has been organized, with $500,000 capital, to install an electric plant at Horseshoe Bend, on the Merced river, and furnish power to the Coulterville mines, incidentally lighting Coulterville. The rich Utica company is to put in a plant at their great mine at Angels' Camp, the mines about Sonora are to be operated by means of this unseen power, and from all parts of the State come reports of like nature. The electrical age is upon us.—Modesto (Cal.) Herald.

It is a surprise to us that something is not done by the Southern Pacific Company towards substituting electricity for steam on the local lines. It would be much nicer, safer, cleaner, and in every way more appropriate. Above all, we have no doubt it would be cheaper. They have large electrical locomotives successfully running in the East, and they would be especially adapted for this work. Alameda is becoming so thickly settled that the big locomotive engines, belching smoke and cinders and making terrible noises with bell and escape of steam are getting out of date.—Alameda (Cal.) Argus.

The lateness of the rains this year, even in the mountain districts, has caused a scarcity of water, and as much of the power which is used in the mines to operate machinery is water power, they have felt the scarcity of it. The water which could be brought to the mines having run out, some of them shut down or have been working only a portion of the force. There is much water power in the mountains, which is so located that it cannot be delivered where it can be used without great cost. The miners have therefore conceived the idea that where the water cannot be flumed and ditched to them they will go where the power is, and by converting it into electric force they can convey it where water cannot be taken.—Stockton (Cal.) Independent.

The purpose [of an electric transmission company soon to be incorporated to construct a plant on the Merced River, near Horseshoe Bend] is to furnish the power required for all the mines in the district, and as there is no power available for that locality except at this point on the river, its importance as a factor of prosperity is self-evident. It is further emphasized by the recent action of the United States Government agents, who have stopped the cutting of wood on the public domain, and threatened wholesale and indiscriminate arrest of trespassers. It may be mentioned in this connection that, as a matter of fact, there is no appreciable amount of wood or timber convenient to this section of country outside of Government land, and if parks and reservations increase in number and area, it will not be many years before there will be a scarcity of fuel for domestic use.—San Francisco Call.

When the city electrician or anybody else makes a showing of figures to the effect that the "actual" cost of Alameda's light for the month of September was no more than $594.84, he is assuming that the tax-payers of this city are fools, and ignoring the fact that they have had nine years' experience with this big, white elephant. Every previous electrician has been a great hand at figures, just like the incumbent. But in the end the tax-payers have always had a fine large expense to meet. There is no use of arguing against electricians' methods of casting up accounts, especially as long as those methods find favor in official quarters; but at the end of the fiscal year we shall publish from the City Treasurer's books figures showing the amount of money that the city has paid on account of its electric light plant, and whatever it is, that will be the only reliable record. We have no hope whatever that it will be less than it has been in the past, and, we believe, from signs that have hung out, that it will be more.—Alameda (Cal.) Argus.

Except in two or three instances, there has been but little difficulty in securing rights of way [for the pole line of the San Joaquin Electric Company]. But now and then there has occurred what the officers of the company are pleased to designate as a "genuine hold-up." They cite the case of a large farmer who asks at the rate of $1000 an acre for the right of way to set poles across his wheat field. But this is child's play in comparison with what a wealthy lady asks for the right of way to set poles for a mile and a half across a rugged mountain where the only use the land can be put to is range for sheep. She asks that, in consideration for the right of way over this mountain, the company cut the wood off the land near the line, and deliver it to her free; put in a telephone in her house and connect it with the city and keep it in repair free; to pay her $100 cash; to pay her attorney whatever he may charge for drawing up the papers and attending to the business; and, in addition, to furnish certain incandescent lights, about eighty in number, free of cost for fifty years. The cash value of what this wealthy lady asks for the right of way across the sheep pasture is more than $50,000. It is perhaps superfluous to say that the electric company will bring suits to condemn the rights of way in the cases mentioned. —Fresno (Cal.) Republican.

In view of the awakened interest on the part of our citizens in the San Jose and Saratoga electric railway, the Mercury has been at some pains to glean some facts that will be of advantage to property owners and business men of San Jose. For this purpose a representative of the Mercury made a tour of investigation at Oakland and points between that city and Haywards, obtaining facts from merchants and other reliable sources as to the effect upon business in those places since the completion of the Oakland and Haywards electric road. This road is but a couple of miles longer than the proposed Saratoga road, and for that and other reasons has many features in common with the enterprise under way in this city and county. The Haywards road, while excellently built and equipped, does not come up to the standard of the road proposed to be built by L. M. Hale, as the rails of the former are but forty pounds to the yard, while those of the latter will be sixty pounds. This difference materially and favorably affects the comfort of travelers, and is an important consideration to those using the road from day to day. Another fact should be borne in mind, and that is that while but $50,000 is asked as a bonus for the Saratoga road, $115,000 was subscribed for the Haywards road. If any business man in San Jose has a single doubt as to the pecuniary benefit of an electric road to this city from Saratoga, we would recommend the attention of such a one to the opinions of the business men in general in Oakland. The increase in population, too, has been remarkable, ranging from 30 per cent. to 400 per cent. along the line.—San Jose (Cal.) Mercury.

Reports of the Month.

COMMUNICATION.

KAMLOOPS, B. C.—Satisfactory progress is being made in the installation of the new telephone and fire alarm systems.

NEVADA CITY, CAL.—The Nevada County Electric Power Company has completed a private telephone line from its power house to Nevada City, and will probably continue the circulation to Grass Valley. The telephone circuit is run over the pole line carrying the 5000-volt two-phase power transmission circuits.

SAN FRANCISCO, CAL.—The Pacific Telephone and Telegraph Company is installing a kitchen telephone service for private residences, which includes the unlimited use of a metallic circuit equipped with the Blake transmitter and express service for $1.75 per month. These kitchen telephones are for outward service only, hence contain no magneto or other calling device.

MISCELLANEOUS.

SACRAMENTO, CAL.—A 20-horse-power multipolar 500 volt Westinghouse motor is being installed by the Southern Pacific Company for operating a drawbridge across the Sacramento river.

GREEN RIVER, UTAH.—Since Nov. 15th twelve car-loads of electrical machinery, costing $75,000, has been received by the South Park Mining Company from the East, and has been shipped to the Placer sand-bar of the Green River, seven miles distant, where it is being set up for the purpose of saving the fine gold that abounds in the sand-bars. Thirty men have been engaged to operate the plant, which will have a capacity of handling 4000 cubic yards of sand per day. Great secrecy is being maintained regarding the process used.

SAN FRANCISCO.—Direct connected Cahill-Hall electric elevators are being installed in the new N. S. G. W. Buiding and the Wilson Block.——Dr. Close, of the Torpedo service, has ordered five miles of six-conductor torpedo cable from the Roebling Company. This cable has an outside diameter of .26 inches, weighs 25 pounds per mile and each conductor consists of seven strands of No. 25 wire.——The Paul Boynton Chute Company has enlarged its electrical equipment by the addition of a 7½-horse-power Westinghouse motor for running a merry-go-round.

INCORPORATION.

EVERETT, WASH.—Copper Queen Mining & Improvement Company. Capital stock, $150,000. Incorporators, W. R. Stockbridge, C. W. Miller, C. H. Boynton, J. E. McManus.

SALIDA, COL.—The Salida Electric Company, to furnish electric light and power. Capital stock, $50,000. Promoters, Geo. A. Goddard, James E. Johnson and Geo. Brennan of Denver.

KALAMA, WASH.—The Orchard Water Company, to maintain and operate water and electric light works in any town in Washington. Capital, $7,000. Promoters, H. Orchard, J. P. Atkin and A. H. Innis.

LOS ANGELES, CAL.—The Pacific Coast Telephone and Electric Motor Company to manufacture telephones, motors, etc., and to construct and dispose of telephone and telegraph lines. Capital stock, $100,000. Promoters, L. M. Gibson, W. C. Harrison, Jno. MacCabe and S. Weathercott.

SAN DIEGO, CAL.—The San Diego and Back Country Telephone Company. Cap tal, $2500. Directors, Waldo S. Waterman of San Diego; J. E. Godvey of Mesa Grande; J. A. Verlagne and Geo. A. Telford of Ramona; S. Rotanzi of Santa Ysabel; W. J. McBean of Julien, and T. Stevens of Witch Creek.

TACOMA, WASH.—The Tacoma Auxiliary Fire Alarm Company, to install electric auxiliary fire alarm systems in Pierce County, Washington. Capital stock, $30,000. Promoters, J. M. Bell, B. K. Worley, D. B. Worley and W. A. Theodore.——Oregon Mining and Water Supply Company. Capital, $20,000. Incorporators, Wallace H. Jennings, J. T. Redmond, G. F. Shaw.

TRANSPORTATION.

MOKELUMNE HILL, CAL.—An electric tramway is to be built to carry ore between the Lamphear works and the Moser mine.

STOCKTON, CAL.—A belt line electric railroad of standard gauge and seven miles in length is to be built along the city outskirts.

SAN BERNARDINO, CAL.—The changing of the E-street road into an electric line and its operation by the Santa Fe system is rumored.

SEATTLE, WASH.—The promoter of the Seattle, Tacoma and Portland Electric Railway Company is H. L. Thomas, who is said to have Eastern backing, and who has a franchise now before the City Council of Seattle.

VANCOUVER, B. C.—The Black Diamond Mine will resume operations in January, soon after which it will install a tramway to the lake shore, to convey ore from the Black Diamond, Little Phil and Little Donald mining properties.

CHICO, CAL.—The project of building an electric railway from Biggs to Palermo and Honcut, crossing the Feather River near the Alexander & Hamman and W. Treat & Son division line, is probable. The same line extending from Biggs to Gridley and from Palermo to Oroville, then to Chico, would make a complete connection of all the principal towns in the county.

BERKELEY, CAL.—Newspapers report that a well-known engineer has been at work for some time drawing plans for the gridironing of Berkeley with electric railroads. It is also the intention of the company for which this engineer is at work to build two large ferry steamers like the San Rafael. The cost of the road, and steamers, wharf, etc., is estimated at $900,000.

PORTLAND, OR.—The Portland Traction Company has applied for permission to change the motive power of its street railway system from cable to electricity. The cable system is to be abolished entirely except on the big hill—Portland Heights. The cable will be run on the hill by electricity. The cars will be balanced on an endless cable, and the power of one going down will compensate for the power expended in sending one up, as is done on the 25 per cent. grade on the Fillmore-street line in San Francisco.

SACRAMENTO CAL.—The rights of way for the Sacramento, Fair Oaks and Orangeville Railroad have been practically secured. ——The Board of Supervisors has published a notice of sale, on January 6th, of an electric railway franchise, to run from Twenty-first and Y streets, this city, by various streets, out the extension of V street and on the upper Stockton road to the Capitol school-house.——The Board of City Trustees also offers for sale, on January 6th, an electric railway franchise for a line on Twentieth street, from V to Y street.

OAKLAND CAL.—The City Attorney has been instructed by the Council to prepare an ordinance forfeiting the Whitmore street railroad franchise along Franklin street.——The electrical equipment of the Hills division of the Piedmont Consolidated Cable Railway Company has been completed and cars have been run over the same, although regular operation by electricity will not begin before New Year. This completes the displacement of the cable system for regular operation on week days, although the cable will be run in addition on Sundays to meet the heavy traffic that then occurs.——E. B. Vandercook, projector of the electric railroad from Oakland to Livermore and the Corral Hollow, has returned from the East, having received substantial encouragement in the way of securing capital for the proposed road.

MAYFIELD, CAL.—At a meeting held at Saratoga on December 2d, the sum of $45,000 was subscribed towards the building of an electric road from Saratoga to Mayfield. Prominent among those present were F. M. Farwell and H. W. Postlethwaite, but it is believed that the meeting was held in the interest of the Saratoga syndicate, whose large land holdings in the vicinity of Mayfield and through West Side, Saratoga and Los Gatos make it important that rail connection with the Southern Pacific be provided. Some of the capitalists who were represented are also interested in the reorganization of the San Francisco and San Mateo Elec-

tric Railway, the present terminal of which is at Baden, but which will soon be extended to Palo Alto and thence to Mayfield. The line will be continued through to Los Gatos.

San Jose, Cal.—L. M. Hale has withdrawn his proposition to construct an electric railway from this city to Saratoga, because of the failure of the citizens of San Jose to subscribe the $50,000 required. The action of Mr. Hale has aroused the public, and the press is now endeavoring to induce him to reopen his proposition.——W. T. Weber, of Burlington, Iowa, proposes to build, equip and operate an electric road to Saratoga, provided the public will subscribe $60,000 to the road on the following terms: This sum of $60,000 shall be payable in two payments; one half shall be deposited in the Garden City Bank subject to his order within thirty days after the construction of the road commences and the iron rails for the road have arrived in San Francisco. The other half of the sum designated shall be secured by first-class notes payable on January 1, 1897, in San Jose, and deposited in the above named bank. Mr. Weber guarantees to commence work within 30 days after the cash deposit of 50 per cent. has been placed in the bank. All this sum must be in the bank by May 1, 1896. In return for such subscription Mr. Weber proposes to issue to each subseriber a certificate to the full amount of his subscription, which will be good for its face value in payment of freight or passenger charges over the road. No one snbscriber, however, will be allowed to collect more than 25 per cent. of his subscription in one year, but he may collect 25 per cent. yearly for four years, thus getting the entire subscription back in four years time. No one will be forced to collect the amount in this time, as the certificates are good until used. Mr. Weber says he has constructed sixty miles of road in Oregon on this plan, and it has worked with wonderful success for the public. He has a fine road in the suburbs of Portland, a system at Dayton and another at Dallas. He says he has constructed many miles of road in the East, and with success in every instance.——The Board of Supervisors invite bids for the sale of an electric railway franchise on January 8th, from a point beginning at the southern terminus of the First-street railroad on the Monterey road, southerly along said road for a distance of 1900 feet.

San Francisco.—The Sutter Street Railway Company has just placed 19,000 feet of 1½-inch rope in its Pacific Avenue and 12,000 feet of 1⅛-inch rope for lower Sutter street, all being of Roebling manufacture.——Four double 25-horse-power Westinghouse equipments have been sold to the Market-Street Railway Company.——The Market-Street Railway Company has concluded to resume the payment of quarterly dividends on and after Jannary 1st, and it is thought that the payment will be at the rate of 20 cents per share per month during 1896. It is reported that the company now has on hand in its surplus fund $563,000 for dividends for paying purposes. Until the recent decision of the State Supreme Court, declaring the $17,500,000 bond issue of the company legal, it was necessary to draw on the surplus in addition to borrowing a great deal of money for the electric road extensions. The Hellman syndicate had agreed to take the first $2,000,000 of the bonds, but declined to pay over the money until their validity was established. The syndicate, however, advanced $1,000,000 in cash to the company on personal notes, with collateral security. This money, with the company's surplus and loans from the Pacific Improvement Company, were the financial resources of the combine for carrying on its improvements, pending a court decision on its bonds.——The construction department of the Market-Street Company has commenced changing the Tenth-street horse-car roadbed into an electric line, and has about finished the Bryant-street system, which will be turned over for regular operation shortly after New Year. The new line will run from Second and Market streets via Bryant to Twenty-sixth and Mission streets, with a branch line on Folsom street running from Second street to the ferries, transfers being exchanged at Second and Folsom streets.——The intention of the Market-Street Railway Company to center an extensive street car system at the Southern Pacific Depot at Third and Townsend streets is announced, in anticipation of the completion of the coast line of the Southern Pacific Company, over which through trains will be run between this city and New Orleans direct without crossing the bay. The Kearny-street electric line at present runs from North Beach to the Southern Pacific depot, continuing on to the Potrero, while it is believed that the recently completed electric lines on Ellis and Turk streets will be continued across Market street, thence down Fourth ond Fifth streets respectively, terminating at Third and Townsend streets. It is not probable that the cable will be displaced on Market street until the electric underground conduit system has been pronounced an undoubted success.——The Tamalpais Land and Water Company has guaranteed an order for 650 long tons of 56-pound steel rails to be used in the construction of an electric road from Mill Valley to the top of Mount Tamalpais, a distance of seven and a half miles. The eventual extension of the road to Bolinas is probable. The maximum grade will be 7½ per cent., and its summit will be at an elevation of 2500 feet. S. B. Cushing, of San Rafael, is the promoter.——The Pressley single track system is undergoing test at the Pacific Rolling Mills, where 400 feet of track has been laid, upon which is run a 32-foot car of the single rail type, which is kept poised by the fact that the weight upon the wheels is considerably below the center of gravity.

TRANSMISSION.

Philipsburg, Mont.—It is said that F. E. Grimes will soon erect a steam hoist on the Trout mine.

Ogilvie, Cal.—The Golden Cross Mining and Distilling Company is installing a 5-horse-power Westinghouse motor.

Merced Falls, Cal.—The Merced Falls Electric Power and Manufacturing Company is clearing ground for the transmission station it expects to erect.

Angels, Cal.—The Utica Mine is about to install a 2000-horse-power transmission plant, which will be the largest installation operated at any mine in California. In all probability Westinghouse apparatus will be used exclusively.

Bakersfield, Cal.—The Kern River and Los Angeles Electric Power Company, through Gen. Chas. Foreman, President, has applied to the Board of Supervisors of Kern county for the rights of way for transmission lines through that county.

Sacramento, Cal.—The material for construction of the independent power circuits is expected from the East in a few days, and soon after the Sacramento Electric Light and Power Company will be prepared to fulfill more of its power contracts.

Provo, Utah.—Manager T. A. Davis, of the Hercules Power Company, is authority for the statement that the surveys for the proposed transmission of the Provo Power Company are now being completed, and that the contract for its erection will be awarded shortly.

Jamestown, Cal.—The App Mine is arranging for the installation of a power transmission plant because of the shut-downs which are necessary before the winter rains set in because of scarcity of water for power purposes at the mine, abundant water power being available unfailingly a few miles distant.

Logan, Utah.—The Hercules Power Company hopes to have its transmission circuits in operation by New Year, and, in addition to furnishing light, the company expects to provide power for the operation of an electric railway system which it is designed shall connect the several towns in this locality.

Sonora, Cal.—Three electric hoists have just been installed by the Westinghouse Company in the Miller & Holmes mine.——Iron pipe in 8, 12 and 14-inch sizes is being delivered for the new pipe line of the Sonora Electric Light and Power Company at the Marble Works, near Columbia, and the new dynamos were contracted for delivery about Christmas.

Livingston, Mont.—The Park View Mining Company, at Crevasse, are arranging to make extensive improvements on their property early in the spring. Development work will be pushed during the winter, and early next season a five-mile flume and a 100-stamp mill, with a complete electric plant, will be placed in operation. J. W. Hulse is the company's superintendent.

SEATTLE, WASH.—The proposition to issue $1,250,000 in warrants for the construction of the proposed Cedar River water system was carried, on December 11th, by a large majority. The scheme contemplates carrying water at high head into this city, where it will be used for running an electric power plant before being run into the city mains. F. H. Osgood is the promoter.

LOS ANGELES, CAL.—Bids will be received by the Supervisors up to 2 P. M. January 22d for a franchise to erect, maintain and operate a line for the electrical transmission of energy for a period of fifty years, commencing at a point on the boundary line between Los Angeles County and Kern County, where the transmission lines of the Kern River and Los Angeles Electric Power Company cross said line, thence in a southerly direction by the most direct and practicable route to the city limits of this city.

PORTERVILLE, CAL.—The Kaweah Irrigation and Power Company is constructing the canal which will supply water for the operation of the proposed plant to be located at Lime Kiln. A mile of the most difficult portion of the canal, which will be about five miles long, is finished. The canal is twenty feet wide at the head-gate; the bottom eleven feet wide, the top thirty feet and the depth six feet. Some of the cuts are 14 to 15 feet deep, and one tunnel is 400 feet long. The canal will carry 200 cubic feet per second, and sixty men and 100 head of animals are now being employed.

SANTA CRUZ, CAL.—Final surveys of the water power of Big Creek have been rendered Fred W. Swanton, of the Santa Cruz Water and Power Company, which contemplates furnishing power for the operation of all the electric industries in this city. A flume 10,800 feet long must be constructed, which will give an effective head of 919 feet, from which the delivery of 585 horse-power in this city is proposed. The generating station will probably consist of two 300-horse-power Pelton water-wheels to operate one 225-kilowatt A. C. dynamo for incandescent lighting purposes, and a 150-kilowatt polyphase dynamo for power purposes.

NEVADA CITY, CAL.—John Martin, contractor for the pipe line, pole line and electrical equipment of the Nevada County Electric Power Company, has completed the construction of the pipe line from the flume to the power house, and it is expected that the plant will be in operation shortly after Christmas.——The contract for erecting the Nevada City pole lines of the Nevada County Electric Power Company has been awarded to the Electrical Construction and Repair Company of San Francisco, which also erected the entire transmission circuits of the company. Fifty-foot yellow pine poles, averaging sixteen inches in diameter at the butt by about nine inches at the top, are being used for all city circuits.

SAN FRANCISCO.—H. H. Clark, of Coulterville, Cal., who is now in this city, states that a new company, to be known as the Bend Power Company, is soon to be incorporated, with a capital stock of $500,000, for the purpose of constructing an electric transmission plant on the Merced river, one mile above Horseshoe Bend, where a 35-foot dam will be built, from which water will be conveyed by a flume one and one-half miles long, giving 93 feet fall. This will develop a minimum of 1800-horse-power during the low stage of the river, which continues from twenty to thirty-five days, while 4000 horse power can be developed for eight months of the year. Over 100 mines are within the district accessible by this power, the estimated cost of which is $150,000. Dr. F. M. Hopkins is the San Francisco representative of the proposed company.

STOCKTON, CAL.—President Doble, of Blue Lake Water Company, recently stated in an interview in this city that his company has "about concluded to erect a power plant at a point on the Mokelumne river, thirty-nine miles from this city. We have an abundant supply of water at that point, brought from about sixty miles from this city. The idea is to use the water first in the creation of electrical power for transmission to Stockton, and after the water becomes what is known as 'waste' to turn it off in a large ditch, and thus irrigate the orchard country around the Langford Colony. The object of a trip I expect soon to make is to meet with the property owners of that section and see if they are willing to assist us in the enterprise to the extent of contracting for water from the proposed canal. The scheme also involves the extension from Lodi of a substantial electric railroad operated by our electric power, back into Amador county, and possibly Alpine county also."

FRESNO, CAL.—The San Joaquin Electric Company is pushing the work of construction along the whole line of works, and is fast closing up the gaps, and expects to have everything in shape by January 15th for the machinery which will arrive about that time. The bridge across the San Joaquin River, one-half mile above the power-house, is completed, and is ready for the teams which will haul the heavy machinery and the supplies. The bridge is of the truss pattern, and is 100 feet single span across the channel of the river, while the approaches are 350 feet long. Six heavy wire cables, which were stretched across the stream and cleated to the rocks on both sides, furnished support for the timbers of the bridge during the work of construction, and when the truss was completed and the structure self-sustaining, the cables were taken out. One hundred and thirty tons of pipe for the line down the mountain is on the ground, and the work of laying it will begin at once. The place for the pipe, from the reservoir to the foot of the mountain, has been cleared of brush and rocks, and the soil has been cleaned away to the solid granite. The pipes will be chained down every few feet to this granite bed-rock. The reservoir is almost finished. and a few days more will see the last scraperful of soil dragged into place on the embankments. The water will then be turned in. The canal is done, and water has been flowing in its entire length for some time. Satisfactory progress is being made with the pole line, and 800 of the 2000 poles to be used have been distributed along the line, and the porcelain insulators have arrived, the shipment weighing 60,000 pounds.

ILLUMINATION.

CONCORD, CAL.—An electric light plant is talked of.

GENESSEE, IDAHO.—The electric light question is being revived.

SAN MATEO, CAL.—The new electric light plant is now in regular operation.

REDONDO, CAL.—The lighting of streets by electricity is being generally favored.

FLAGSTAFF, ARIZ.—Davis & Phelan have been granted an electric light franchise.

FORT BRAGG, CAL.—C. H. Wilson contemplates erecting an electric light plant.

ELKO, NEV.—W. T. Smith is to install a direct current central station in this place.

BENICIA, CAL.—A 125-horse-power engine has been placed in the electric light works.

WILLIAMS, ARIZ.—C. S. Wyncoop will be manager of the new Electric Light Company.

SAN PEDRO, CAL.—Ivan E. Tutt has been granted a 25-year electric lighting franchise.

USAL, CAL.—The Usal Lumber Company has installed a 30-light arc dynamo and plant.

FAIRHAVEN, WASH.—The steamer Lydia Thompson is to have incandescent electric lights.

DAVISTON, SAN DIEGO CO., CAL.—Plans for an electric light system are under consideration.

FORT BRAGG, CAL.—C. H. Wilson has been awarded a franchise for an electric lighting plant.

MURPHYS, CAL.—The electric light plant was started up by F. A. Mitchler on November 16th.

FORT BRAGG, CAL.—Chas. H. Wilson has been awarded a franchise for an electric light plant.

Williams, Ariz.—Electric lights are talked of, and a franchise for same has been granted.

Ferndale, Cal.—Wm. Kerri and Frank Nelson have applied for an electric lighting franchise.

Red Bluff, Cal.—The Sierra Lumber Company has installed a 300-light incandescent lighting plant.

Monmouth, Or.—An effort is being made to improve the water works and put in an elecric light plant.

Dunsmuir, Cal.—E. M. Cutting is installing an electric lighting plant at the Tie Works at Chestnut.

Rossland, B. C.—The Rossland Light and Water Company has about completed its electric installation.

Dallas, Or.—An effort is being made to improve the water works and place an electric plant therein.

San Francisco, Cal.—H. L. Middleton has purchased a 200-light Westinghouse incandescent dynamo.

Colton, Cal.—The Trustees have adopted an ordinance of intention to erect a municipal lighting plant.

Eugene, Or.—An incandescent lighting plant has been placed in the gymnasium of the State University.

Great Falls, Mont.—The Castner Coal & Coke Co. will put in a $22,000 electric plant for lighting purposes.

Vancouver, B. C.—The Western Electric Lighting, Heat and Power Company is to light the city by electricity.

Eureka, Cal.—The Pacific Lumber Company is installing a 34-kilowatt incandescent Westinghouse lighting plant.

Grass Valley, Cal.—The W.Y.O.D. Mine is installing a 33-kilowatt Westinghouse incandescent lighting plant.

Forest Grove, Or.—W. S. Ingles, Wm. Kane and J. C. Woods have been appointed water and light commissioners.

Miles City, Mont.—This city has voted to isssue bonds for the purchase of the water works and electric light plant.

Murray, Idaho.—An incandescent lighting plant has been installed in the mine and mill of the Daddy Company.

Fortuna, Cal.—Swartzel & Williams are installing an incandescent lighting plant, using Westinghouse apparatus.

Santa Clara, Cal.—The Index favors the erection of a municipal plant of 50 arc lights and about 500 incandescents.

Jackson, Cal.—B. E. Letang, of the Gas Company, has ordered a 30-kilowatt Westinghouse alternator for his new plant.

Los Angeles, Cal.—A 12½ kilowatt slow speed multipolar incandescent dynamo has been installed in the Baker Block.

Miles City, Mont.—The Council has authorized the issuance of $17,000 in bonds for an electric light and water works plant.

Honolulu, H. I.—Mr. W. I. Warriner has been appointed electrical inspector of the Honolulu Board of Fire Underwriters.

Redwood City, Cal.—The Westinghouse Company has sold a 45-kilowatt alternator to J. George Gardner for use in this place.

Fort Jones, Cal.—Emanuel Perrira has purchased a 45-kilowatt two-phase lighting plant from the Westinghouse Company.

Grants Pass, Or.—The Maybelle Mining Company has installed an incandescent lighting dynamo at the Gold Basin mines.

Trail, Wash.—An electric lighting plant will be put in to light trails near smelter, and the smelter plant will also light the town of Trail next year.

Rossland, B. C.—The War Eagle Mine is installing compressors, machine drills and hoists, and will put in an incandescent plant to light the mine and town.

Winnemucca, Nev.—The installation of a gasoline engine and incandescent dynamo in the State Capitol Building is being considered.

Roslyn, Wash.—Mr. Sprandel has been given sixty days to start up his electric light plant or remove his poles and wires from the street.

Nelson, B. C.—The Nelson Electric Light Company expects to have its new plant in operation by December 20th. John B. Bliss is electrician.

Porterville, Cal.—The Pioneer Land Company has agreed to put in an incandescent lighting system, provided sufficient patronage is assured.

Eureka, Cal.—The Eureka Lighting Company has entered into a contract to furnish the city with 63 arc lights for one year at $500 per month.

San Jose, Cal.—The San Jose Light and Power Company has installed an additional Brush No. 7 arc-lighting dynamo complete, with all accessories.

Juneau, Alaska.—The Electric Light Co. has installed a Pelton water-wheel to run under a seventy-foot head, displacing the turbine heretofore used.

Glen Ellen, Cal.—Governor Budd advocates the installation of a plant to furnish electric lights, heat and water in the Home for the Feeble Minded.

Jackson, Cal.—B. E. Letang, of the gas works, has completed the pole line for his new electric plant, and expects to furnish current for lighting shortly.

Watsonville, Cal.—Francis Smith has purchased two 35-kilowatt two-phase Westinghouse dynamos, to displace the single phase apparatus now in use.

Honolulu, H. I.—Welch & Co. have purchased a 12-kilowatt general incandescent lighting plant from the Westinghouse Co. for use on the Ewa plantation.

Willows, Cal.—The Board of Supervisors has advertised for bids to be in on January 8th, for a 250-light gas plant for the Court House and County Jail.

Berkeley, Cal.—The University grounds are to be lighted by electricity from the electric plant in the department of electrical engineering of the University.

Lakeview, Or.—Hon. H. V. Gates, who put in the electric light works at Klamath Falls, is expected here to figure on a roller mill and an electric light plant.

Woodland, Cal.—The arc lighting plant of the Woodland Electric Light Company is fully loaded, and an increase may be necessary. Homer Dunton is electrician.

Portland, Or.—J. F. Steffan has secured the contract for the construction of the Government light ship No. 67, which will contain an elaborate electric light plant.

Sutter Creek, Cal.—The station of the local electric lighting company is to be enlarged by the addition of a 120-kilowatt alternator, which has been ordered from the General Electric Company.

Spokane, Wash.—The Oppenheimer Rolling Mills are to be lighted by electricity.—The Consumers' Liight and Power Company is erecting 75-foot poles throughout the city for its new plant.

Santa Clara, Cal.—It is proposed to install a municipal lighting plant in the city water works, with the surplus of $7000 that remains from the $60,000 bonds voted last year for the water plant.

San Jose, Cal.—The Board of Trade has adopted a resolution favoring the municipal ownership of an electric light plant, and has asked the Council to submit the proposition to a vote of the people.

Grass Valley, Cal.—The contract for street lighting for 1896 has been awarded to the Grass Valley Gas and Electric Light Company, John Glassen, Manager, for $125 per month, all night lighting.

Forest Grove, Or.—The city has purchased the Canning Electric light plant for $10,500, and will enlarge same and operate it in conjunction with the new water works.

Santa Rosa, Cal.—The Merchants' Lighting Company has added a 250-horse-power Buckeye engine to its lighting plant. Herman Webber is manager of the Company.

Oroville, Cal.—The Oroville Gas, Electric Light and Power Company has enlarged its plant by the addition of a new Westinghouse alternator, and is now rewiring the town.

Nelson, B. C.—The Nelson Electric Light Company has received its electrical apparatus from Petersborough, and the new plant will soon be in operation. John B. Bliss is electrician.

Petaluma, Cal.—The Petaluma Electric Light and Power Company, largely owned by the estate of the late W. S. Pierce, has been sold to J. B. Burdell, the price paid being understood to be about $20,000.

Astoria, Or.—There is talk of an electric light plant being installed at some convenient point on Yaquima bay, so as to reach all the towns willing to patronize such an enterprise, provided 400 lights are guaranteed.

San Leandro, Cal.—The people have voted to issue bonds for $10,000 for the erection of an electric light plant, the vote being 274 for and 25 against the proposition. The use of a gas or vapor engine is probable.

Colton, Cal.—Specifications have been issued by E. C. Sharpe, electrical engineer, for the installation of a 50-kilowatt municipal lighting plant to be operated by a 3-phase motor, run by power to be taken from the Redlands plant.

Haywards, Cal.—The Council has awarded the contract for the city lighting for the ensuing year to the Haywards Electric Light Company for $9 per 2000 candle-power arc lamp per month until midnight on moonlight schedule.

Santa Monica, Cal.—A 55-kilowatt incandescent lighting dynamo, direct connected to a 9½x15-8ths Union Iron Works vertical engine, running at 380 r. p. m., is being installed in the Soldiers' Home. The distinctive feature of the plant is that it is to burn 220-volt lamps.

Burke, Idaho.—H. Jackman and Norman Ebley will build an electric light plant in Canyon Creek, for the purpose of supplying lights at Burke and Gem and all intermediate points. The plant will be located at the head of the Frisco flume, the water being brought from a point on Canyon Creek.

Salt Lake, Utah.—The Salt Lake and Ogden Gas and Electric Light Company proposes to meet the heavy cut made in incandescent electric rates by the Citizens' Electric Light Company by putting in Wellsback burners burning natural gas, at the rate of ten cents per lamp per month, if necessary.

Cascade Locks, Or.—A Pelton water wheel will probably be installed for driving a dynamo to furnish incandescent lights to this place, the wheel being operated by water taken from a 10-inch wrought iron pipe that has been laid for operating the hydraulic headgates of the canal, the fall being 600 feet.

Montesano, Wash.—Albert Daub declined to accept the term for the electric light franchise offered him, and the proposition is again open. Water power was to have been used, and it is stated that, outside of the lights to be taken by the city, the monthly income of the plant would probably be in excess of $150.

Spokane, Wash.—The Board of Public Works has asked the City Council for permission to place a 60-light incandescent plant in the water works, but the opinion is held by some that the city ought to put in two dynamos sufficient to furnish 200 arc lights for lighting the city instead of putting in this proposed small plant to furnish lights for the water works alone.

Vancouver, B. C.—An agreement with the Western Electric Co. had been practically accepted by the Common Council, when G. De Wolf appeared and offered to light the city for 26 cents per lamp per night for the present number of lamps, which is 1½ cents cheaper than the figure of the Western Electric Company. Mr. De Wolf presented a certified check for $1000 as a token of good faith, and his proposition will receive consideration.

Seattle, Wash.—Among recent installations by the Seattle Gas Fixture Company was a 50-volt 150 ampere hour storage battery plant, using chloride cells.——Samuel Hill and some of his Eastern associates have purchased the Seattle Gas and Electric Light Company, the reputed purchase price being $750,000. The Company was organized in 1873, with John Leary as the principal owner. Some years afterward A. A. Denny and Dexter Horton became associated with the enterprise, and shortly after the great fire of 1889 they sold their interest to H. G. Struve, Maurice McMicken and Lester Turner, who were in control when the transfer was made to Mr. Hill.

San Francisco, Cal.—A 4-kilowatt incandescent dynamo direct coupled to a high speed engine has been placed on the Steamer Everett.——The Golden Gate Dredging Company has installed an incandescent plant on its new dredger.——Forty constant potential arc lamps of the General Incandescent Arc Lamp Company have been sold by the Abner Doble Company for use in the Sutro Baths. Inverted arcs, with reflectors, will be used over the tanks.——The Christmas tree at the Denman Grammar School was lighted by over 100 miniature incandescent lamps, manufactured by G. E. Lamont.——Messrs. J. W. Brooks & Co. sold over 25,000 "Universal" incandescent lamps in Oregon and Washington between Nov. 15th and Dec. 10th.

Riverside, Cal.—E. C. Sharpe, electrical engineer for the city of Riverside, has issued specifications for the installation of the municipal lighting plant for which bonds have been issued. Power will be purchased from the Redlands Electric Power and Light Company, and will be conveyed to the city over a special circuit. The plan necessitates the installation of a 300-kilowatt three-phase generator at the Redlands power house, seven miles from Redlands, and the construction of an independent circuit thence to Riverside, line loss being 5 per cent. and the distance approximately fifteen miles. Fifty kilowatts of energy is to be taken from the Riverside circuit for delivery at Colton, and in Riverside is to be erected a complete sub-station for municipal lighting purposes. Bids must be in by December 30th.

Alameda, Cal.—City Electrician G. A. Wiese's report for November shows the cost of operating the municipal lighting plant during that month to be $1,308.77, from which is to be subtracted $194.71 for new construction, making the actual running expenses to be $1,114.07, the service consisting of 100 city lights on moonlight schedule and 1,375 commercial incandescents. The income from private consumers was $323.15. The income from the city at the same rate as charged for gas previously, but with twice the service in some cases, $71.17; total income, $394.32. Cost of electric street lighting to the city, $719.74. Cost per month per lamp for November, $7.20; for October, $6.16; September, $5.94; August, $7.03; average cost per lamp per month to the taxpayer, $6.58.——A proposition emanating from the Oakland Gas, Light and Heat Company, that bids be asked (1) for furnishing electric power for operating the arc and incandescent generators in the municipal plant, and (2) for furnishing current for the maintenance of the municipal arc-lighting plant for street purposes only, has been rejected by the City Trustees.—Trustee Clark, of the Electric Light Committee, states that work will be commenced soon on the improvement to the city's electric light plant. A lot has been bought at the foot of Park street, and new buildings will be erected to accommodate new machinery. It is intended to put in a 350-horse-power engine, three new boilers, and dynamos sufficient to run 3500 incandescent lights. The improvement will cost $15,000, which has been provided for in the tax levy.

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Wave Motor Experiments

THE little village of Capitola, a pleasant suburb of Santa Cruz, California, is fast assuming a new importance, particularly in the mechanical engineering world, because of the series of experiments that are now about to be carried out there, and in which the promoters believe will contain the results of all the experiences hitherto derived regarding the utilization of the energy of the waves of the ocean in the development of power. Almost from the earliest appreciation of the value of power the mind of man has been captivated with the possibilities of wave motors, but the fact of the commercially successful utilization of such prime movers is yet to be recorded.

On the Pacific Coast several rather extensive experiments have been made, two of which, in San Francisco, gave naught but discouragement in repay for the efforts and money which their promoters expended. Both of these experiments were carried out on the rocks beyond the Cliff House, and one of the wrecks remaining, and shown in Figure 1, exists as a monument to the fond but delusive hopes of the inventors. The first experiment at the Cliff House was that of the Steen wave motor (Figure 1). The rocks at the point of its location form a sort of cave, where the breakers rush in and out, sometimes with tremendous fury. Over the entrance of this cave a bridge was constructed, from which depended a huge paddle that was designed to swing, pendulum-like, back and forth in the waves. From its lower extremity a pitman was carried back toward the cave to the piston of a pump, sixty-five feet distant, the idea being that the latter could be operated from the stroke of the paddle. The timbers of the mechanism were of great strength, but not sufficiently so to withstand the beating of the waves, with the result that first the pitman was demolished and then the main timbers of the paddle gave away, and with it the perseverance of the inventor succumbed, as the wreck now standing evidences. It was designed that the pump should force water from the ocean to the top of the hill, at an elevation of between three and four hundred feet, and the pumping plant was put in with this intention, but the first rush constituting the maximum power of each wave, imparted such a blow to the pumping equipment as to not only prove the weakness of the machinery installed, but also to demonstrate the fact that something was radically wrong with the design of the apparatus.

The next effort at the Cliff House, and which constitutes the last endeavor there made towards the utilization of wave power, resulted in the building of elaborate paraphernalia, the ruins of which still exist.

The principle upon which this apparatus was constructed was the one yet predominating in the minds of inventors, namely, that the energy of waves may best be made available by the rise and fall of floats, but although the conditions were favorable for the test, and an expensive plant was put in, the inventor's hopes were not realized and the explosion of the dynamite-ladened schooner "Parallel" off the Cliff House rocks seven years or so ago, wrecked the outfit, and afforded a fitting pretext for its abandonment. In this, as in the Steen motor, the ambition was to operate pumps for forcing water to the hill top, but if reports

FIGURE 1—*A Wrecked Wave Motor.*

be true, it was found that the capacity of the apparatus was limited by the weight of the float, which, together with the rise and fall and the time factor, was insufficient to develop material power. The Gerlach water motor, which is now under test at Capitola, exceeds all previous experiments on the Pacific Coast in point of magnitude and cost. Its general form, which is shown in the illustration at the heading of this article, is in particular a development of an experiment made at Long Beach, Cal., about two years ago. In this experiment a paddle wheel thirty-six feet in diameter, and having paddles six feet wide by three and one-half feet deep, was erected on a temporary structure of eight piles that were driven at the extremity of a wharf extending 1,100 feet into the sea. When a wheel is suspended in the rollers with axis parallel to the beach, the wheel will tend to rotate in the direction of rolling from the shore, because of the greater force of the inward than the outward motion of the waves. Although the action of the wheel is of an oscillatory character, there is thus a tendency to effect its revolution, which led to the construction of a wheel in the Long Beach experiment, rather than the building of a pendulum like vanes or paddles. The power of the wheel was made available by a rope passed about its circumference, which was connected to a pulley fitted with differentiating pawls and ratchets, so as to give the driven shaft continuous rotation, and under test the apparatus lifted a weight of 8,500 lbs. to a height of eighty feet in thirty seconds, representing a theoretical energy of a trifle over twenty-two horse power.

The results obtained at Long Beach were satisfactory to the inventor, who at once set about the organization of a company to prosecute experiments on a larger scale, and the fruits of his labors are represented in the Capitola experiments. A wharf extending into the sea a distance of 750 feet has been leased for twenty years, and upon the end of the pier has been extended 200 feet of very stable wharfing, upon which has been erected the plant shown in the accompanying illustrations. The general scheme of the Gerlach wave motor will be understood from a study of the first illustration. Two sets of vanes or paddle wheels swing with the surges of the waves, and from the extremities of each, chains fit to sprocket wheels, equipped with the differentiating gear, to be described, and by means of which rotation is imparted to the shaft carrying the large fly wheel shown. In detail, this main shaft is thirty feet in length and eight inches in diameter. The fly wheel has a diameter of twenty-four feet six inches; it weighs 60,000 lbs., its grooved face has a width of four feet. Upon this shaft has been placed four sprocket wheels, two for each paddle, and a portion of which are clearly shown in Figure 2. Each of these sprocket wheels is five feet in diameter, and is provided with eight right-hand toggles, two and one-half by six inches in size, which act as pawls. By running two chains from each paddle, one of which chains is connected direct to its sprocket wheel and the other being carried over an idler wheel before being secured to the sprocket wheel, the same direction of pull is given to the shaft for either stroke or swing of the paddle. The paddles are each mounted upon a shaft eight inches in diameter and fifteen and one-half feet long, and are so equipped as to have a range of lift of thirteen feet in order that they may be kept at the most advantageous depth of immersion at all tides. The paddles are raised and lowered by screws in the pillars, which are actuated through worm gearing by means of power applied to the sheaves shown from the small sheaves on the main shaft. The paddles are of a uniform width of twelve feet, and are nine feet deep, hence there being three paddles to each equipment, there are 324 square feet of surface to each mechanism, or a total of 648 feet of paddle surface. The paddles weigh eight tons each, and swing with a radius of thirty-two feet, describing an arc, the maximum chord of which is twelve feet, while the average

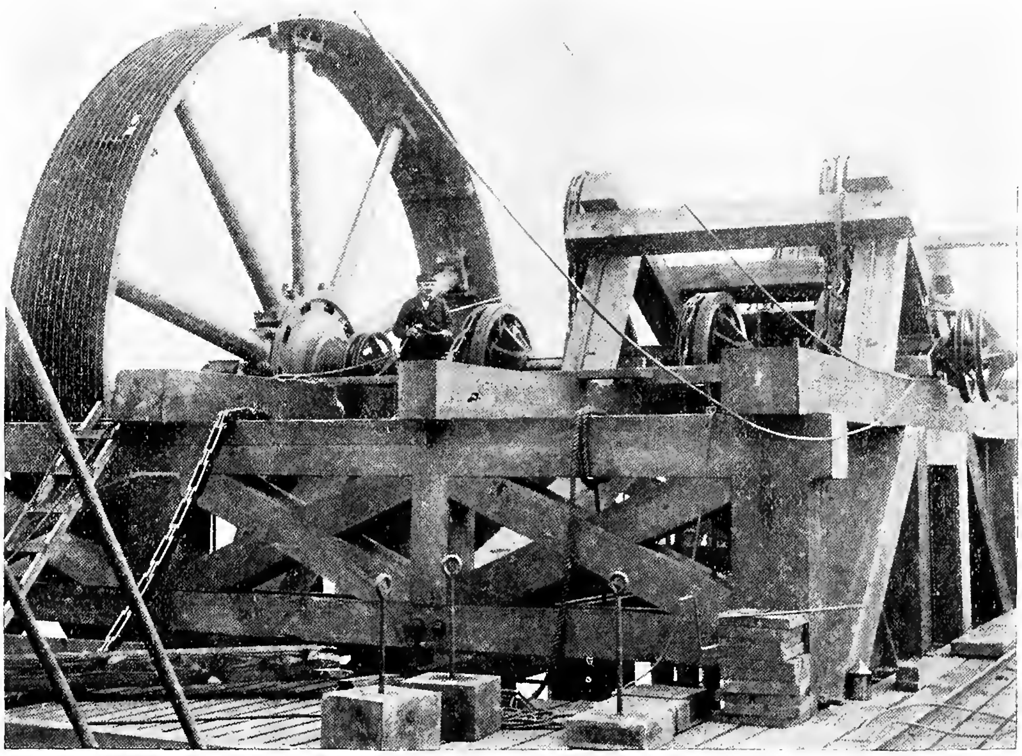


FIGURE 2—*Main Shaft of the Gerlach Wave Motor, showing the Sprocket Wheels and Toggle Grips.*

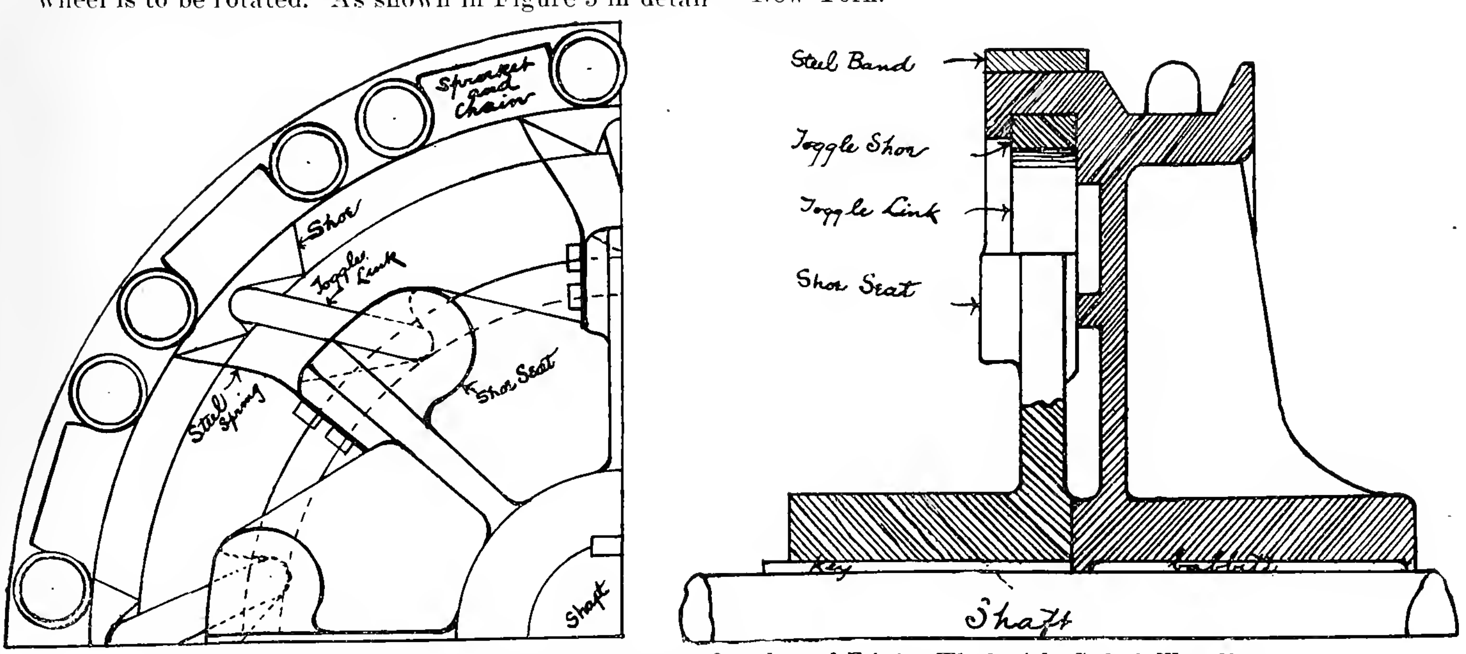
chord ranges between seven and eight feet. The swing occurs eight times per minute, thus giving thirty-two pulls per minute to the main shaft from the two paddles.

FIGURE 3—*Paddle Suspension of the Gerlach Wave Motor.*

A vital feature of the mechanism will be understood by reference to Figures 4 and 5, showing the arrangement of sprocket wheels on the main shaft and by means of which it will be remembered the main fly wheel is to be rotated. As shown in Figure 5 in detail the sprocket wheel proper really forms an idler that were it not for the toggle links, would revolve freely in either direction. Abutting this is the eight arm spider shown in Figure 5, which is rigidly keyed to the shaft. Referring again to Figure 5 it will be seen that an extension of the flange of the sprocket wheel is made to over-reach aportion of the spider wheel. The under side of the flange is grooved to confine within it the steel toggle shoe shown in elevation in Figure 5 and in section in Figure 4. This shoe is of peculiar formation and is held in place first by the tggle link shown and second by the constant pressure of a steel spring, the tendency of which is to cause slippage when the idler is run in a left hand direction. When the direction of revolution of the idler changes however, the toggle shoe grips with it as in a ratchet and pawl motion, and the shaft rotates. The drawing is at the scale of 1½ inches to the foot.

On January 9th the first and only effort was made to test the machinery, when it was found that the toggle pawls in the sprocket wheels on the main shaft were not properly proportioned and did not grip, and thus, instead of producing the desired friction, the sprocket wheels slipped without turning the main shaft. The motion imparted to the sprocket wheels by the paddle chains was satisfactorily regular, but in order to satisfy those present as far as possible, one of the steel toggles was made to fit temporarily, when the main shaft began to revolve at a considerable speed, thus demonstrating the practicability of the idea. The trouble with the toggle pawls constitutes a minor defect, which is now being remedied by the Atlas Iron Works of San Francisco, the contractors for the plant, and it is promised that the machinery will be in proper working order early in February, when it will be fully tested and the results published. The inventor expects that at least 200 horse power will be developed, which it is proposed to utilize by compressed air.

"We must congratulate you upon the general get-up and amount of good reading matter the 'Journal of Electricity' contains, and we consider it as good as any of the other American electrical periodicals," writes one of the leading publication houses of London and New York.



FIGURES 4 and 5—*Side and Sectional Elevations of the Sprocket and Friction Wheels of the Gerlach Wave Motor.*

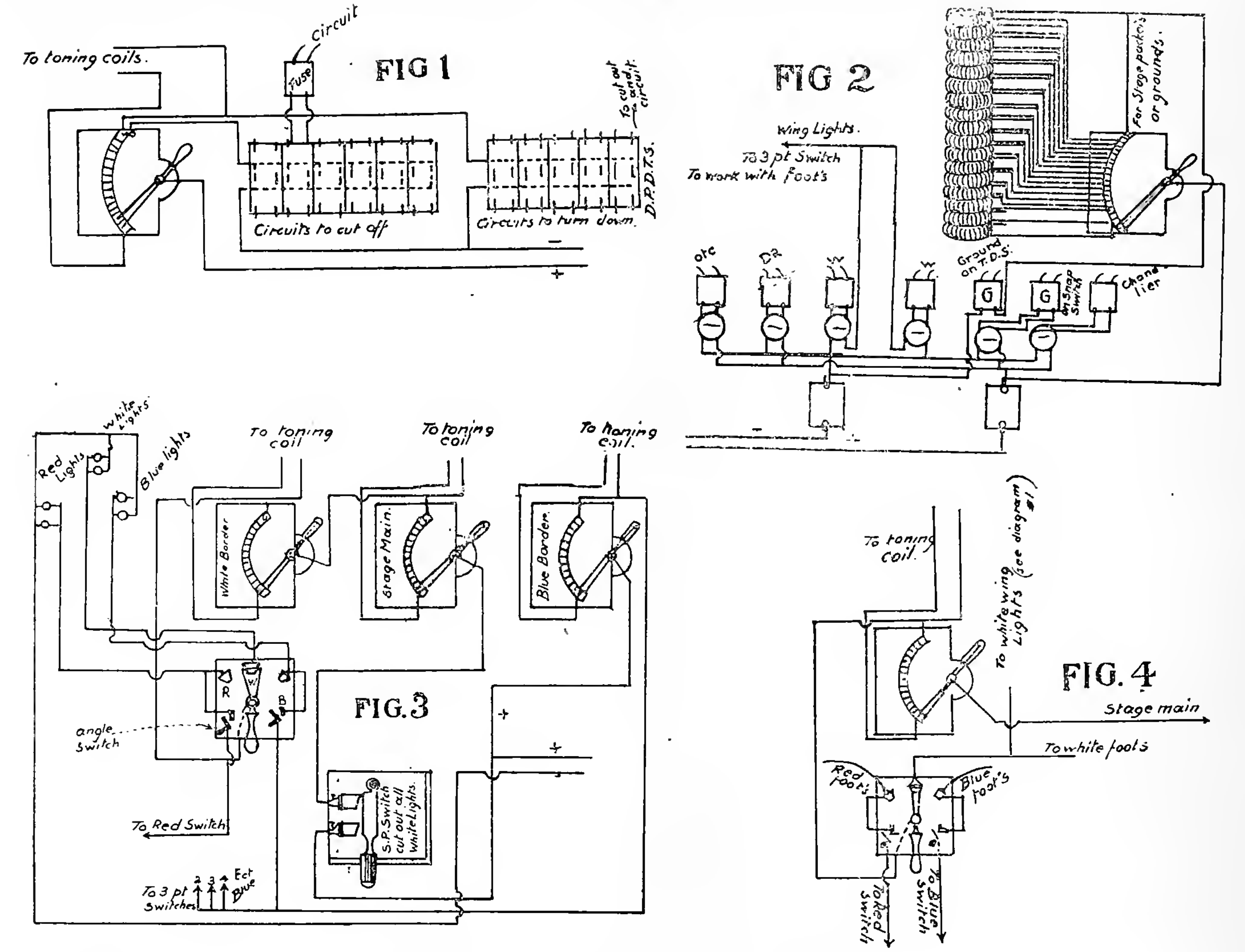
In the Journal of Electricity, San Francisco has one of the most creditable industrial publications issued on the Coast. Its gain is steady and rapid.—The Book and News Dealer.

THE CONTROL OF THEATER LIGHTING.

A switchboard for the control of the incandescent electric lighting of theaters must embody the following requirements: (1) It must be confined to a small space in order that every portion of it can be under the instant control of the switchboard operator. (2) It must be of the greatest possible simplicity in operation, in order that the greatest number of changes may be made with the least effort or number of motions. (3) Its equipment must be such as will effect the greatest possible economy in the use, control and dimming of lights. (4) Its design must effect many switching combinations so as to give any possible lighting effect required—a difficult requirement when it is remembered that moonlight, sunrise and sunset effects, together with other changes requiring perfect graduations and manipulations of light such as tableaux, dark changes, lightning, etc., must be carried out. The contractor must have a full appreciation of the art of blending colored and white lights, and above all, his experience in electrical installation must be of the very highest order to secure the most important features of permanence and absolute reliability of workmanship.

There is no doubt that alternating currents constitute the ideal means for theater lighting, not only by reason of its flexibility in conversion, but because of the fact that in the use of toning or choke coils is effected a most satisfactory means for dispensing with the use of resistances, which constitutes a means of control that is wasteful of energy, hence very expensive. It is with a view of describing a modern theater installation operated on alternating circuit, that the accompanying drawings and illustrations are given. The subject chosen is the Macdonough Theater of Oakland, Cal., which is believed to be one of the most perfect equipments of the kind on the Pacific Coast, if not in the country. The switchboard in question is shown in Figure 5.

The reaction or toning coils constitute the only piece of apparatus used which is not of a familiar type, and these differ radically from ordinary toning coils in that each step of toning is accomplished throught the cutting in or out a single choke coil. It was found by experiment to be desirable that there should be a range of seventeen steps in the toning of the lights, to accomplish which, each toning switch contains seventeen toning coils, which are generally coupled in a series in the main current and commutated by the toning switch, as clearly shown in Figure 2. There is, therefore, no movable secondary coil or core, but each of the coils used is a single reaction coil of ring type, wound with a single length of wire, varying in size according to the current carried on the circuit. The core of the coils consists of a length of seventeen feet of soft iron baling band, less than 1-32 of an inch in thickness by about $\frac{5}{8}$ of an inch in width, which is rolled into a ring having an inside clearance about five inches. The different convolutions of the iron



FIGURES 1, 2, 3, 4—*The Control of Theatre Lighting.*

band may be insulated magnetically from each other by rusting or by paper, the latter being used in the present instance, and after the ring is finished, it is taped and dipped into plaster of Paris several times until it is entirely encased by the plaster to a depth of about ¼ of an inch. After having been thoroughly dried out the plastered ring is again taped and wound with wire as necessary, which finishes the coil. This form has been adopted after long experiment as best satisfying the conditions, and it is found that the use of plaster of Paris proves most effectual in deadening the hum of alternating current apparatus, as only by the closest listening at the choke coils can any hum be detected.

In Figure 1 may be found the detail of the auditorium or front-of-house switches, which shows the combination for changing to duplicate circuits or allowing any circuit to be cut out completely or to throw any circuit on to the turning down switch. All switches used are of the double pole, double throw type, the house circuits being connected with the fulcrum of the switches. The main toning switch is connected in series with the choke coils as shown in Figure 1

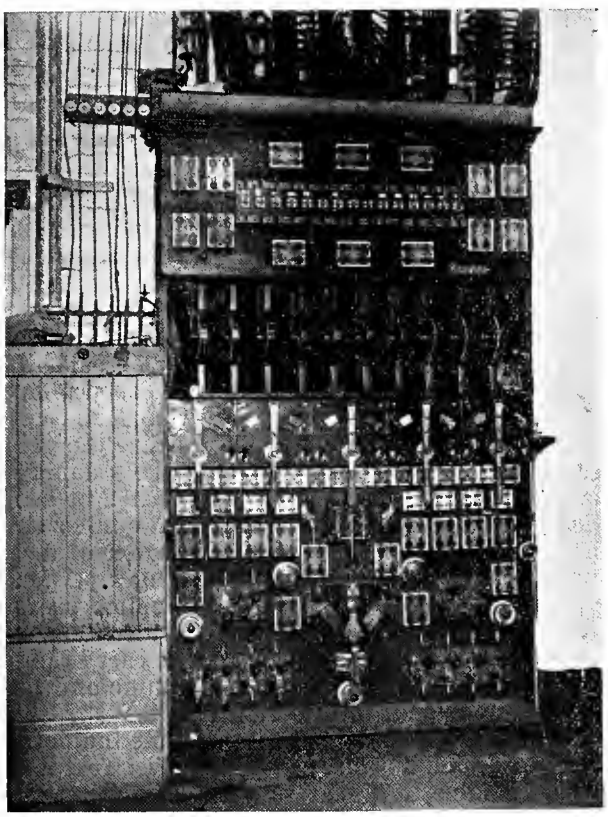


FIGURE 5—*The Macdonough Theatre Switchboard*

(the detail of the toning coil switch being as in Figure 2), and to dim any or all circuits, it is only necessary to throw the switch to its lower "turn down" position, while the throwing of the switch to the upper portion cuts out the toning switch from the circuit, thus burning the house lights to full brilliancy.

As previously described, Figure 2 shows the connections of the special choke coils, and in addition shows the arrangement of snap switches and fuse blocks for dressing rooms, stage chandeliers, wing lights, ground or stage lights, etc. Wing lights are ordinarily used in connection with the main footlight switch outlined in Figure 4. The sketch shows in particular the combination of foot and wing lights. One side of each circuit is taken from the snap switches in Figure 2 and carried to the three point switch in Figure 4, thus enabling the potential of the circuits to be turned down with the foot lights, or cut out, as desired. The colored wing lights are operated in a similar manner, except that they are connected to the red and blue points of the three point switches only. This three point switch is really a main switch, and is ordinarily termed the ground switch, because it controls the lights that are used on the stage floor, such as bunch lights, piano lamps, and lights that are used in places where the foot or border lights might cast undesirable shadows. The term "ground," therefore, is thus used in a theatrical and not in an electrical sense, and from the ground switch, circuits are carried to pockets or receptacles cut into the stage for attaching floor plugs, etc. Four of these pockets are connected to the turn down switch, and two are connected to the map switches marked G, thus allowing some to be cut out and others to be turned down, as desired.

Figure 3 shows a main single pole switch for cutting out all white lights on the stage and also a main turn down switch for toning all white lights feeding through these two switches, G G (Figure 2.) Current can thus be taken to the individual white border lights or to various border switches, as the case may be, thence for the border light switch to the lever of the three point switch W, and on to the lamps, whence the circuit continues to the main line and is completed. When a quick change is desired from white to red or blue, the switch lever is thrown from the point W to the point R or B, respectively, as required for use in tableaux or living pictures. Should the white and red lamps on the same border be wanted, then the lever on the three point switch will be set on the white point W, and the small angle switch on the same base will be closed on to the circuit R, when the main colored border switch may be turned on, or if the blue border is needed simultaneously with the white border, the other angle switch will be closed with the point B, and the main blue border switch turned on. Connected to each white border switch is a three point switch having two angle switches, R and B, all of which may be thrown on to the main colored switches, so giving control of each border individually or collectively, independent of the quick changing three point switch. The red border switch is not shown as it is, simply a duplicate of the blue one. The three arrows marked 2, 3, and 4, lead to respective three point switches and connect to the angle switch, as shown in B, Figure 3.

The installation described was designed by Mr. J. A. Lighthipe engineer of the Pacific Coast District of the General Electric Co., and installed under the direction of Mr. Frank T. Whorf. By its use it is possible to accomplish any combination or blending of lights that may be desired.

A LITERARY CURIOSITY.

Searchers for curious rendering of English and those who take as jokes books of the class of "English as she is wrote" would do well to look over our Berlin contemporary "Helios," where all articles are printed in German, French and English and are apparently written by the same German who speaks of a telephone station when he means a telephone instrument and a conduit when he means a wire besides in a thoroughly unique manner putting in his unintelligible "already" and stringing along his verbs at the end of the sentences until one reading the articles feels again like the school boy trying to get his Greek lesson with the aid of "crib."

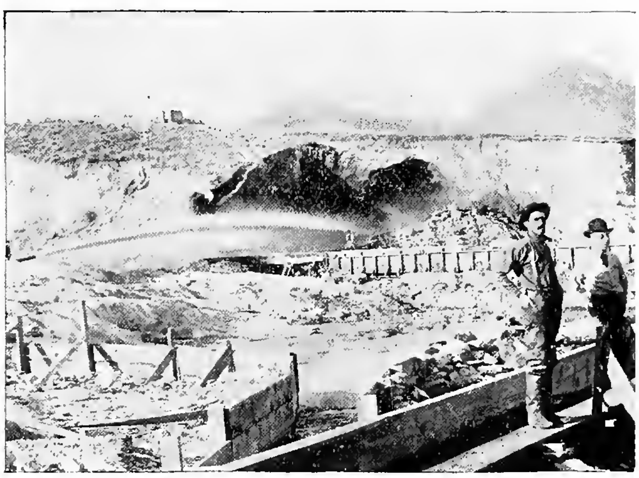
Mining

LIGHTING HYDRAULIC MINES.

By W. W. Briggs.

The difficulty in lighting large hydraulic mines heretofore has been in getting the light just where it was needed on the gravel bank in such a position that the man at the pipe could see the condition of the ground at all times. When we consider that the pipe washes on banks ranging from 50 to 150 feet in height, and that the method employed to get the gravel to the sluice is to undermine the bank, causing all the top dirt to come down with a rush resemling that of a land slide, also that the impact of a large body of water under high pressure against the bank throws a dense cloud of spray, the dissatisfaction attending the use of an ordinary form of arc lamp close enough to the work, becomes apparent.

In many portions throughout the West it is necessary to work the Placer mines night and day in order to fully utilize the water that is available only during certain portions of the year. Prior to the introduction of electric lighting, it was customary to build bonfires in huge pots, each of which would consume about 1½ cords of wood, costing $7.50, and requiring



Lighting Hydraulic Mines.

the services of one man costing $3.00, or a total cost of $11.50 per night per fire. Naturally therefore, the the item of illumination formed aserious one in the operation of a Placer mine, and the first steps taken to reduce this expense were made at the North Bloomfield mine in Nevada County, Cala., which installed a three lamp, 6.8 ampere Brush arc lighting dynamo in 1879. Open arcs were used and the plant is still in operation.

A recent installation at the mines of the Lemhi Placer Mining Co., in the Salmon River district, Idaho, has successfully overcome these difficulties and at the same time demonstrated that mines of this character can be better and more cheaply lit by electric light than by any other means.

A small ditch two miles in length was constructed which furnished water under 130 ft head for driving a 36 in., Pelton wheel for the dynamos, and also water for camp-buildings and fire purposes. The plant contains two dynamos; our ten lamp 2000 cp. Wood arc machine for the mine, and one 5 kilo-watt constant potential 110-volt machine for lighting the camp buildings.

The lamps which were generally placed behind the giants, were Thomson-Houston electric headlights mounted on stands to allow the raising and lowering of the front of the lamp by means of a hand scr-w so that the beam of light could be thrown on any portion of the mine. They were also fitted with turntables to permit the light to be thrown in any horizontal direction.

The lamps were never placed closer to the hydraulic giants than 300 feet and were arranged in two groups of three lamps each so as to break shadows, and the cost of lighting the mine in this manner is found to average $3.18 for a 12-hour shift.

The accompanying illustration of a Placer mine in the Salmon River district gives an idea of the difficulties encountered. The constant shifting of the scene of operations makes it imperative that the location of the light should be changed frequently. The electrical work is therefore largely of a temporary nature, and as a general thing the pole line is not a model of excellence, but while the character of the work is not such as will gladden the heart of the electrical engineer, he cannot but be lost in admiration of the beautiful effects produced in the illumination of these mighty streams of water. In some instances, notably in the Pioneer mine the writer has seen as many as seven rainbows in the spray.

DEEP MINING PUMPS—A SUGGESTION.

By A. L. Fish.

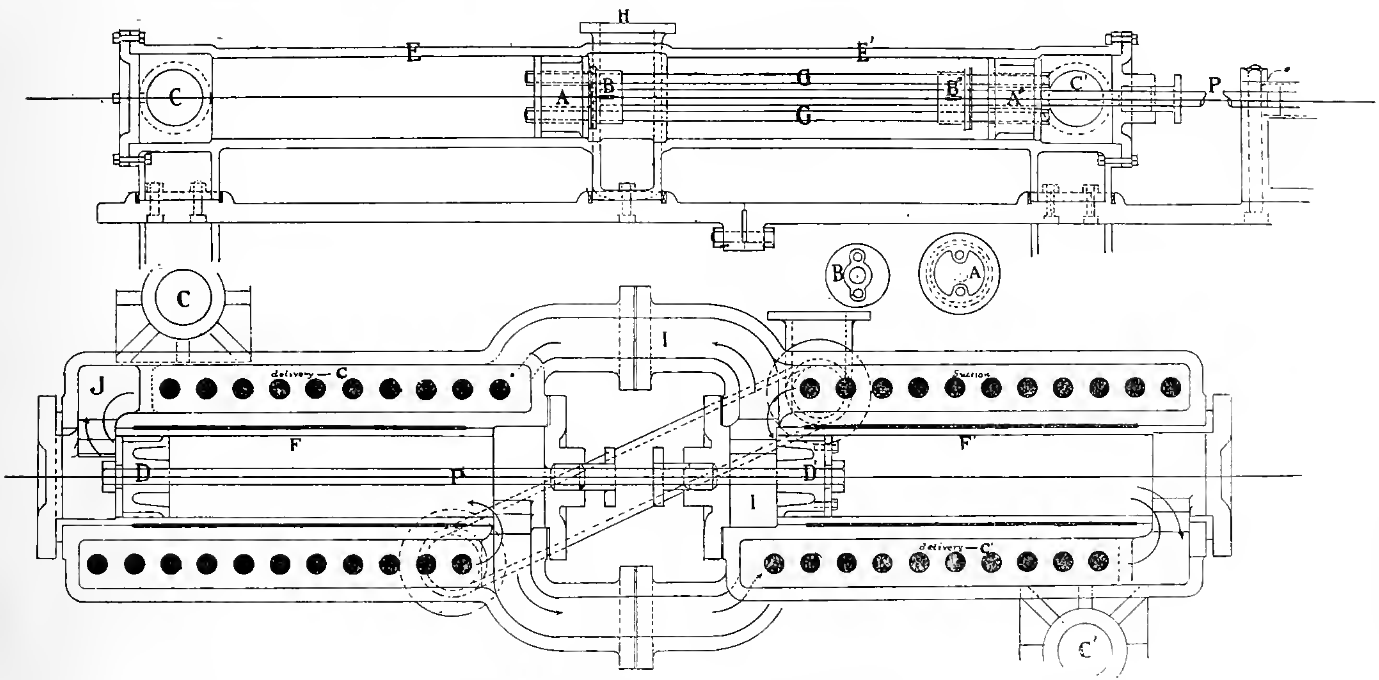
Having had a long experience in the utilization of machinery for mining purposes and being therefore quite familiar with the many difficulties attending the operation of pumps in deep mines, I have given some thought to methods by which these difficulties may to a certain extent be eliminated, or at least reduced by the greatest possible degree. It may be said in general that the placing of machinery in deep mines entails its operation under disadvantageous circumstances hence the conclusion follows that the greatest success will be attained by placing the pumping machinery on the surface. It is this idea that has prevailed in the erection of pumping plants under circumstances as would permit the operation of a direct plunger at the bottom of a mine having a perpendicular shaft, but this is a condition so seldom prevailing that it can receive no material consideration. The almost invariable practice has been to carry the pump and its motive power down into the mine and forcing the water up from it to the surface.

I have taken some pains to work out the details of a system which I think presents novel features and which I beleive to be the simplest device yet submitted. In brief, it consists of the utilization of a column of water placed in motion by suitable mechanism at the surface, and which delivers its energy to cylinders having pistons placed in the mine which when sec in motion thereby overbalances the weight of a similar column of water, discharging an amount from it at the surface equal in volume to the capacity of the cylinder of the mine pump. The plan necessitates the use of two discharge pipes from the surface, which are used alternately for discharge and power purposes. The column of water merely constitutes therefore, a shaft or connecting rod forming an extension of the pump system. The power communicated through rod added to weight of one column of water forces mine waterwith receding clumn to surface.

Referring to the accompanying outline sketch, the two pipes referred to are designated as C and C. The mechanism contained in the cylinder E E is located

on the surface and really constitutes a force pump as its function is not to lift water but to force water down into the mine by means of power applied to the piston P by means of some suitable prime mover. The plan shows the arrangement of the parts of the apparatus just after having passed the extreme end of a stroke. The piston heads AA play in the cylinders E E respectively and are rigidly bolted together by means of the rods G G upon which slide the valve seats B B. These valve seats are rigidly keyed to the piston P, hence it is clear that the stroke of the piston is imparted to the piston heads through pressure of the valves B B on the hollow piston A A. It is clear surface changes its stroke the valve B leaves the piston head A, the valve B closes with the piston head A, and water is forced down through the pipe C, striking the plunger D, which is at the right hand end of the cylinder, and the water in the cylinders F F is forced through the delivery valves and pipe C, to the surface as before. The suction chamber H is always filled with water taken from the mine, while the water discharged into the shaft pipe consists of equal parts of water taken from the suction and of water that has supplied the energy for the preceding stroke, as clearly outlined in the drawing.

The simplicity of the parts of the mechanism and



Deep Mining Pumps—A Suggestion.

that when the pump is making a stroke in one direction, in a left-handed direction, for instance, the valve A remains in open, affording a free way for the passage of water., from the pipe C into the cylinder E, thence out through the discharge pipe H.

In the mine the shaft pipes C C are coupled to the deliveries of the tandem cylinder pump C C as shown in the drawing, while the suction connections are shown with equal clearness. The pump piston P has rigidly connected to its extremities the piston heads or pump plungers D D, playing in the cylinders F F respectively. Both the suction and the delivery orifices, are fitted with suitable valves and the arrangement is that of a double acting pump with the exception that when the column of water in the pipe C is forced downward by the advance of the piston head A in valve saet B at the surface. The energy thus imparted to the water is carried through the chamber J, to the piston head D while advancing. The plungers D D throw the volume of water in the chambers F F into the shaft pipe C through the delivery valves C on the cylinder F. Obviously, then, as the volume of water forced down into the mine equals the capacity of the cylinder F (which is equal to that of the surface cylinder E or E'), this capacity is unity, and by the contrivances, the utilization of one unit of capacity of water has forced two units of water up through the pipe C, through the valve B, and the discharge exhausts H. In other words, the pumping down of one volume of water pumps up two volumes of water, and the difference is discharged. When the engine at the the practically entire absence of the source of power from the mine likens the mechanism to that of a hydraulic ram, so far as the mine itself is concerned, to a remarkable degree. Neither depth of mine nor surrounding conditions as to dampness or other exposure will affect the operation of the system, and the advantages presented would seem to outweigh in many instances the additional expense that the construction of the two shaft pipes necessitates.

PERSONAL.

Mr. H. Fisher Eldridge, of the Portsmouth Electric Company, of Portsmouth, N. H., is visiting San Francisco.

Mr. John Maguire, president of the Maguire Manufacturing Company of Chicago, builders of the well-known Maguire railway truck, is wintering at San Rafael, Cal.

"The Journal of Electricity" is an admirable publication in every way, and deserves the support of every-one interested in electrical matters.—L. B. Pemberton, Los Angeles, Cal.

The specimen copies of the "Journal of Electricity," which you kindly sent induced be to become a subscriber. Herewith I enclose a cheque for $2.00 for one year's subscription.—I. Fujioka, Lecturer in the Engineering College of the Imperial University, Chief Engineer of the Tokyo Electric Light Company and of the Miyoshi Electric Manufacturing Company, Tokio, Japan.

A NOVELTY IN STEAM YACHTS.

Many of the yachtsmen who frequent the Marin County shores of the Bay of San Francisco have experienced considerable chagrin during the past summer by having their steam or gasoline launches distanced by a curious little whale boat that darted in and out of Tiburon courting "brushes" with the crack launches of the yacht clubs. This peculiar little craft did long service in the Artic region as a whale boat until with the waning of the whaling industry it was secured by Mr. John Bonner, now Master Mechanic of the San Francisco and North PacificRailroad Co. who equipped the boat with interesting machinery of his own designing and which has been described briefly in a recent issue of "Power", without reference however, to the specific use to which the machinery has been placed.

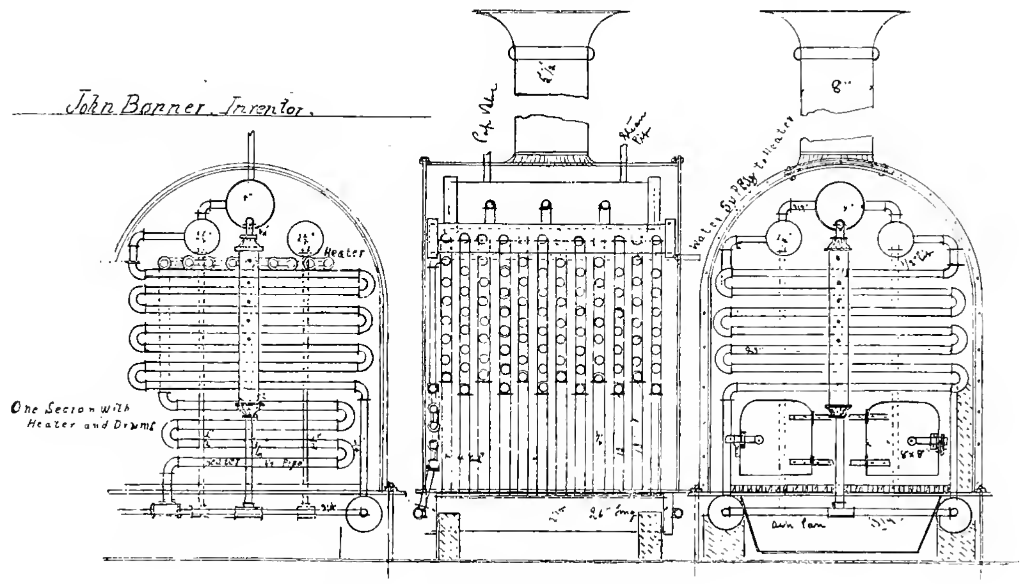


FIGURE 3—*A Novelty in Steam Yachts.*

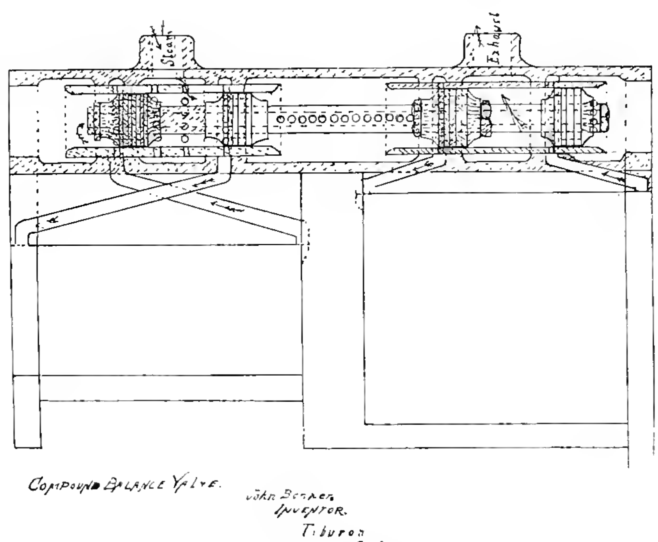


FIGURE 2—*A Novelty in Steam Yachts*

The hull of the boat measures 30 feet in length and is of 6 foot beam, having an estimated capacity of three tons burden and it easily attains a speed of thirteen miles per hour over a measured slack water course. The steam equipment is clearly shown in Figure 1, and consists, of a water tube boiler of a novel construction, that is licensed to carry steam at a pressure of 250 lbs., per square inch, and a com pound steeple engine, the particular novelty of which is the balanced reciprocating valve motion. The boiler, shown in outline sketches in Figure 3, constitutes a very cheap, simple and compact appliance, in which a thorough circulation is maintained, in which a great amount of heating surface and a large grate area are afforded, and in which the steam is thoroughly separated from the water. The construction gives ready access to all of the parts, and as no special styles of fitting are required in its building, the boiler may be readily set up by a skilled gas or steam fitter from standard pipes. The boiler, including its casing, weighs 350 pounds, and its dimensions are 20 x 24 x 34, and it is ordinarily run at 180 pounds gauge pressure. The boiler is made throughout of 1-inch pipe, with standard fittings, and, as shown in the cut, contains two mud drums, two separators and one superheater.

The dimensions of the engine are, $2\frac{3}{4}$ x $4\frac{1}{4}$ diameter, by $4\frac{1}{4}$ stroke. Its weight complete is 90 pounds, and it drives direct a 3-blade, $22\frac{1}{2}$-in. phosphor-bronze propeller. As stated, the peculiarity of the engine rests in the valve motion, which is fully shown in Figure 2. Among the advantages of Bonner's reciprocating valve is the fact that its construction does away with the use of a receiver, the steam chest and all pipe connections, together with the use of one set of links and eccentrics. The valve is a solid tube, and is all lathe work.

The engine as here erected will deliver $7\frac{1}{2}$ nominal horse-power continuously at 400 revolutions per minute, and the mechanical features of the reciprocating valve are such that if desired, the engine may be run at the speed of 1,000 revolutions per minute, or even greater.

EXTRAORDINARY ABUSE OF BOILERS.

The important decision in the contest between the Philadelphia Edison Electric Light Company and the Abendroth and Root Manufacturing Company has been extensively noted in all the electrical papers. The accidents occuring to the Root boilers in the Philadelphia station have been much discussed and widely exploited by competitors of this water tube boiler. It is therefore gratifying to learn that the boiler manufacturers have been completely exonerated in the courts and the blame for the accidents laid upon the Philadelphia Edison Company. One of the most remarkable facts brought out in the case was that in reference to the manner in which the boilers had been handled. How far such work is practiced in electrical supply stations will perhaps never be known though it is interesting to note the methods used in this case. The instructions to firemen given by the Edison Company were that full steam pressure should be maintained at all times whatever the hazard, with the result that the boilers were often called upon to steam at more than twice their rated capacity, so rapidly that at times the tubes of the boilers could not deliver the steam as fast as it was made and actual superheating took place in the water tubes, with the result of many burnt out tubes and of boilers broken under the influence of water hammering within the boiler itself.

When the wind blows all straws point one way and this with many others at the present time point to the necessity of cheap and efficient storage in order to relieve all parts of the machinery in the station from excessive strains and uneconomical systems of working.

SPLITTING SCIENTIFIC HAIRS.

A curious computation has been made by Mr. Alexander Hogg of Fort Worth, Texas, on the influence of the revolution of the earth on the speed of the trains. His object in making the calculations was to show that when the New York Central road made its record run on September 11th of 436.5 miles in 407 2-3 minutes. or at an average speed of 64.26 miles an hour, it retarded the speed unnecessarily by running from New York to Buffalo, instead of in the opposite direction. His figures indicated that the difference of weight in the New York Central train when running east and when running west with a speed of sixty miles an hour is, on account of the revolution of the earth, about 1-830 of the total weight when at rest. As the train weighed 565,000 pounds, this computation indicates that if the run had been toward New York the engine would have had to haul about 309 pounds less. These figures have been analyzed by another engineer, who finds some slight errors in the mathematical part of the theory. He says that the increased weight going west is about 154 pounds, and the decreased weight going east about 183 pounds, making the saving by going east about 337 pounds. He also suggests in a sarcastic manner that as the moon draws movable bodies away from the earth when it is above us, it might be well to suggest to the New York Central officials that, as the tides travel from east to west, they may perhaps offset the disadvantages shown by Mr. Hogg by starting when the moon is propicious, and, as they would "keep in the tide" while going west, they may still be able to make fast time in that direction, even if the engineers learn of the disadvantages of centrifugal force when they are trying to make Buffalo.

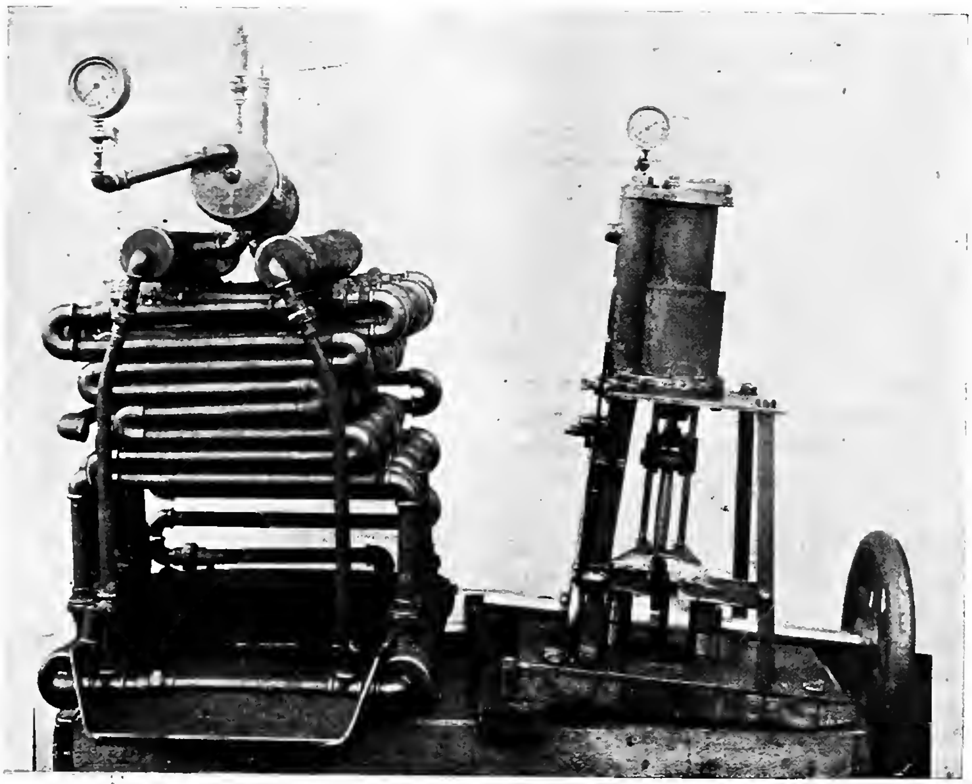


FIGURE 1—*A Novelty in Steam Yachts.*—(*See Page 8.*)

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

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F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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EDITORIAL.

CONCERNING MUNICIPAL OWNERSHIP

The discussions of the municipal ownership of quasi-public works such as the telephone, street railroad, the electric lighting plant or the gas plant have been so distinctly colored by wishes of the authors in the discussions that one is often at a loss to determine what is the true basis of comparison. In one plant where the operating cost is low the advocates of private lighting will attempt to show that important items are omitted from the calculations; in another, they will preach upon the injurious effects due to the increased number of office holders entailed by such a plant. The advocates of municipal ownership argue now upon the low rates to consumers and again upon the freedom from franchise difficulties enjoyed by those cities having their own supply plants. No common ground seems to have been reached in the discussions and no satisfactory means of comparison of the various plants attempted have been suggested. The extreme advocates of municipal ownership will occasionally admit that they regard nothing beside the cost of supply to the consumers, arguing that it matters little to them whether the muncipal plant is operated in a manner economical or uneconomical provided that they are supplied with lights at a low rate. Such a ground seems to be entirely untenable to a student of sound economics and if we take either extreme it might rather be said that we care nothing for the rate of supply but only for the cost of production since an excessive rate is a matter which cures itself by inducing competition.

It is every man's individual business to see that the rates he is paying for his supplies are not beyond the limits of a reasonable profit, but a wasteful production is an eternal waste of the world's store of labor and energy and it is no more good economics to pay many men small sums for work they are doing badly or not at all than it is to pay a few excessive profits upon their business ventures. The question therefore is not one of rates entirely, but is primarily one of engineering; that system must be judged to be the best which will bring out the best engineering and furnish the supply at the lowest rate of production whatever may be the charge for distribution. It is unfair to charge interest rates upon such a municipal plant as that in Detroit, where maintenance charges are included in running expenses, when under similar conditions interest charges would not be made in a private manufacturing concern; on the other hand there are but few of the municipal plants installed upon the best of engineering lines and manipulated economically and it seems that such a condition must necessarily hold until the time comes when the great bribes now offered for successful political jugglery may be removed from the field of politics. If there were no tariffs to vote which could enrich the friends of congressmen, no harbor bills to advance the price of their real estate, no rise or fall of stocks that might be influenced by their votes, it would then be possible for men to be elected to government offices who would administer manufacturing establishments economically but until that time comes, the politician will be the man capable of taking financial advantage of his public vote and it is hardly within human probaility that men of this class will ever lose their hold upon the smaller concerns of everyday life or administer public works economically or to the best financial advantage of the people at large.

HIGH POTENTIAL SYSTEMS

We noted in last month's issue the installation of a plant on the Pacific Coast equipped with 220-volt incandescent lamps. It is interesting to find that these high voltage incandescent lamps can be manufactured in such a practical manner that they may be used in a business installation but we must remember that there is more in this departure than the comparatively simple problem of lamp manfacture. The use of a 220-volt lamp in a simple multiple arc distribution effects a greater saving than can be accomplished with the ordinary 110-volt lamp on a three-wire circuit, but as a three-wire distribution has not been found capable of completely solving the problem of a wide lighting district we may expect that the introduction of this high voltage lamp will be immediately followed by its use in the multiple wire system, which may mean the eventual introduction of a potential at least as high as 440 volts between the outside mains of the three-wire distributing system. Already we know that Edison Companies have encountered much difficulty in installing its low voltage three-wire system without the presence of excessive leaks especially where the wires have been laid under ground. With the doubling of the voltage we must therefore expect to see the abandonment of their low insulation methods and the question at once arises whether satisfactory cables and junction boxes can be obtained for a house to house distribution using this high e. m. f. and if they can be obtained whether it will

be possible for them to be economically installed. English engineers have been much concerned about the insulating powers of fittings and it is said by their journals that a complete reorganization of the requirements for fittings must take place before high voltage lamps may be considered as safe. In this country we have for some time past used in the best installations only a thoroughly vitrified porcelain as a support for the contact points in either switches, fuse blocks, sockets or lamp bases, and, provided the clearance spaces are great enough, it is hard to see how there should be any necessity for a better system of insulation than we are now using. All of our switches and most of our sockets are designed of ample proportions to withstand an e. m. f. as high as 220 volts and this has been proved throughout the country by the extensive use of standard fittings across the outside mains of the three-wire systems where motors are installed. The safety fuse system will require a complete reorganization where these high voltages are employed but, as such reorganization is already in progress for application to our present system, the changes necessary will be easily made since we are daily learning the requirements for the safety fuse upon any circuit. These things being so, it may be considered that the problem of the installation of high voltage incandescent lamps upon either two or three wire circuits in this country involves mainly the question of the quality of the incandescent lamp itself. Our manufacturers have looked with suspicion upon any lamp of higher voltage than 110 volts, but we find that in Berlin 150-volt lamps have for the past five years been successfully used with candle powers as low as five and eight, which is certanly a matter of greater difficulty than the manufacture of a 220-volt 16 c. p. lamp. Two and a half and three-watt lamps have been successfully produced on this side of the water and in the light of these facts there seems to be no reason why American manufacturers should not turn out a 220-volt 3½-watt lamp with a 600-hour life which would be fully satisfactory to central station men and purchasers of current. There seems, therefore, to be no reason for apprehension in the installation of this system either on the score of danger to life or from fires; though this increase in voltage will make more than ever necessary the rigorous inspection of every electrical installation and require throughout the system a more perfect class of workmanship.

CROAKS AGAINST EDUCATION

One of the most important problems at present faced by electricians is found in the electrical engineering profession. We may properly question whether there is a present need for the great number of electrical engineers annually graduated from our various technical schools, whether the education offered by these institutions is calculated to fit their graduates for the duties of life or whether the opportunities offered to the graduates sufficiently warrant their becoming electrical engineers. This extensive system of electrical engineering education has been called by some an electro-mania and condemned consequently in a wholesale manner, the statement being made that the young students are deluded by the remarkable opportunities offered in times past to those who were familiar with the electrical science. This seems to be a part of the general outcry that complete education will unfit men for the common everyday duties of life and render them less rather than more capable of earning their living in business fields. Possibly there is a foundation for this wailing over an electro-mania should the graduate of a technical college look for employment solely as a well-paid engineer within the restricted lines of the profession called electrical engineering, but we believe that a broader view of technical education and especially of electro-technical education will alter the conclusion very considerably. Should the graduates only be fitted for designing electrical apparatus or the management of large central station plants it would undoubtedly be true that more men are being yearly educated than can possibly find employment, but with the advance in the application of electro-technics to the business of the world we find that not solely in the manufacturing, designing and superintending branches of the business are men required with extensive electrical knowledge, but that within the lines of many other businesses and professions electrical knowledge forms a strong basis for usefulness. A few companies throughout the country may be monopolizing the installation of electrical machinery but at the same time the general introduction of electrical operation is hindered by a lack of knowledge on the part of possible users of electrical apparatus. The mining superintendent who lacks sufficient knowledge of electrical processes to manage such machinery will hesitate before making use of it though its economy may have been definitely proven to him where it has been installed under favorable conditions. The transmission of electricity and its extensive application from natural sources of power is greatly limited by the lack of knowledge on the part of superintendents of manufacturing concerns and of business men whose capital is involved in them. Indeed so many elements of detail must be considered before the steam engine plant may be economically removed in favor of the electrical transmission plant that it can only be contemplated by one capable of judging the comparative efficiency of the two plants under the particular circumstances, and without electrical knowledge this judgment may not be satisfactorily arrived at. Many of the older mechancal engineers realizing this have made themselves familiar with electrical processes so thoroughly that they are amongst our best electrical engineers and this should be the goal held before the young electrical engineer that his knowledge does not limit his usefulness to a single specialty, but that by it he has become familiar with a new source of energy and that he has at his command the method for the transformation of power which is not available to those unfamiliar with his science. The acquirement of an electrical engineering education is not therefore to be con-

sidered as limiting a man's power but rather as a means of making him better adapted to entering complex fields of business, of manufacturing or of the transformation of power with a mind not limited to one source of energy transformation, but equipped with a knowledge of the usefulness of many. It is his duty to guard against the unreasoning application of electricity as well as to boldly appreciate its availability when it may introduce any economy. So long as the world stands we will hear this croak against education as we do that against the introduction of machinery; and it is a source of congratulation rather than of fear when we realise that the mass of men appreciate the value of advancing knowledge in spite of the reprogressive spirit manifested by a few individuals.

FOR PEACE OR FOR WAR

Listening to the rumors of possible war between the most highly civilized countries of the world we are every day struck with the fact that our boasted civilization has not eliminated from men altogether their pugnacious character; nor, so long as development consists in a combat with environments, should we expect that pugnacity should be eliminated from humanity. Whether we have war or not is determined therefore by our circumstances and whether a nation has more to gain or lose from combat with some other people. Every advance that we have made in the arts and sciences is involved in this question and we naturally ponder over the possible effect for peace or for war of our latest engineering development. Much of this development has been concerned with the introduction of electrical engineering; does the science of electricity therefore make for peace or for war? Every warship, every battery, every command of men is equipped with electrical appliances of one sort or another, making the engines of destruction more certain and more terrible in their action, making war more deadly and more to be feared; but fear does not always deter men from combat, though it may compel them to require a grevious cause for fighting. Looking at it in this way the introduction of electricity, as the introduction of the Maxim gun, may be said to make for peace. This, however, is not the true peace nor a strong bond between communities. What we have done in uniting the business relations between people and what we have done toward making the mutual understanding of one universal thought more easy is the true possible advance. The telegraph has created a financial solidarity amongst business men which involves all nations in the loss of any one. Disasters in the Argentine were quickly felt in London and spread to the entire world, the news and the effect flying over wires across mountains and beneath seas. Every man throughout this broad land makes daily use of the manufactures of the world and no great manufacturing company, wherever it may be located, can be considered as localized in its influence, foreign capitalists have invested in its shares and foreign purchasers use its products. Diplomatists feel that a slight conflict between any two civilized nations will involve the whole civilized world and this because the telegraph and the telephone have enabled all peoples to be involved in another's prosperity. This makes for peace more strongly than any show of armed force or any development of destroying machinery and is more the safeguard of harmony between nations than are the fleets and the armies of many powers.

THE VAN DEPOELE DECISION

It is difficult so soon after the recent decision sustaining the Van Depoele underrunning trolley wheel patent to estimate its complete significance and until the final decision before the Supreme Court it may be too early to believe that any importance whatever is to be attached to it; but at the same time the patent seems to be one of unusual clearness and the decision is unusually emphatic therefore we must consider that the situation must be faced, even should the rumored consolidation between the Westinghouse and General Electric Companies be effected. This decision, if affirmed, would place in the hands of the General Electric Company the entire present system of trolley railroads and where motors other than their own are used upon any roads either some new system of trolley contact must be adopted or a royality paid to the owners of the patents. The policy of exclusion of all other motors from the field can hardly be contemplated by the General Electric Company unless it is willing to face combined opposition from all the electric railroad managers since it is not conceivable that they will submit calmly to any system which will shut out competition between motor manufacturers and which will compel them to use but one class of apparatus. Underground conduit roads cannot be considered as a complete solution of the problem since the conduit has not yet been developed into a financial sucess, however completely the engineering difficulties have been overcome. Sliding shoe contacts have been used to a considerable extent and the Siemens-Halske people have employed a single stretched wire, though until these methods can be installed noiselessly they would hardly be tolerated in addition to the present objections to trolley construction.

Electrical patents sustained only after many years of use involve so many interests and raise so much opposition that their complete exploitation in the hands of any one company involves so great an amount of diplomacy that up to the present time not one has proven itself to be greatly to the financial advantage of its owners and there is no doubt but that this history will be repeated in the present case though it behooves the users of the underrunning trolley wheel to prepare for a fight upon patent rights in which their own position may be made strong only by a firm co-operation amongst themselves.

Passing Comment.

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

ELECTRICITY FROM GARBAGE CREMATION.

In the "Electrical Engineer" of December 11th Maurice Barnett calls attention to the fact that American engineers have taken but slight advantage of garbage crematories for the economical distribution of light and power. The subject explained by Mr. Barnett is not as simple as might be considered by the casual observer. It is not possible to drive the furnace of a garbage crematory at a varying rate, as the fuel to be consumed contains a vast amount of water and ash so that it is only with difficulty that it may be made to burn at all. In many cases the heat obtained by the consumption of the dried product is only just sufficient for drying the green refuse and where there is a surplus of heat the amount is so small that it can only be made available where the production of power proceeds at a steady rate. The problem, therefore, is one of the storage of energy. In Germany, where storage batteries are cheap, the energy has been stored electrically from garbage crematories and even in small cities a considerable expenditure for machinery and storage batteries has been found to be economical. One plant in England uses thermal storage upon the Halpin system which has been advocated in this country by Nelson W. Perry. This of course requires a greater amount of storage capacity than is necessary where electrical storage is made use of since the energy consumed in engines and dynamos must be retained as well as the energy used for lighting which determines that thermal storage is only justified by the excessive cost of electrical storage. With the decrease in the cost of storage batteries that seems now inevitable, and with a growth of confidence in their reliability we may hope in the future to see the energy contained in the offensive garbage piles of many of our smaller cities made use of for their illumination.

HOUSES FOR TROLLEY SUPPORTS.

We are so accustomed in this country to find the householders in narrow streets antagonizing by every means in their power any electric railroad passing in front of their doors that it does not occur to us to think that the blame must lie somewhat upon the management of the electric railroads. Surely this must be to an extent true, for we find that in Germany, where we commonly understand the burghers to be less progressive than those of our own cities, co-operation between householders and the trolley roads extends to the permission for the attachment of trolley supports to the houses along the line, these trolley supports being carefully designed by architects to conform with the general design of the houses themselves. One of these supports, illustrated in the "Electrical Engineer" of December 18th, shows how carefully the work is carried out and may be a lesson to our trolley road managers that steps towards the conciliation of their neighbors will not be to their loss, but rather to their own financial advantage.

THE BURTON ELECTRO-SMELTING PROCESS.

We noted a couple of months ago some of the absurd claims made by George D. Burton for his method of electro-smelting where, assuming that his process was perfectly efficient, almost three times the amount of heat was required for the work which he claimed to do than was delivered to the apparatus. We note in the "Electrical World" of December 7th an article by Paul Hoho on Hydro-electro-thermal heating, where some experiments have been performed with the "Water Pail" process used by Burton with the result that in place of an efficiency of 100 per cent only about 37 per cent of the energy was made available. While this low efficiency is all that has so far been established for this process the method seems to offer many possibilities in practical work where great efficiency may be neglected.

The method consists in connecting the object to be heated to the negative electrode of a dynamo capable of delivering upwards of 150 volts and plunging the object into a salt water bath contained in a vessel connected to the positive pole. A layer of hydrogen is immediately formed around the negative electrode and as an arc is established across the hydrogen envelope the object is heated with only a slight elevation of temperature of the enclosing bath. This does away with the expensive transformer of the Thomson system and as the heated object is enclosed in a hydrogen envelope the injurious effects of an arc in the open air is avoided. The process seems to be one well adapated to such work as the local annealing of armor plates which has recently been described and to many forging processes applied to small objects in which the Thomson system cannot be made applicable. It is seen therefore that the method has its legitimate place aside from the absurd claims that have been made of its efficiency.

CLAIMANTS FOR TELEGRAPHIC HONORS.

The publication of the letters from descendants of Alfred Vail and Joseph Henry as claimants for the honor of having invented the electro-magnetic telegraph have led many to suppose that the "Electrical World" was taking up in a partisan manner the claims of these workers to the belittling of the name of Morse, but those who have perused and criticised these articles should not judge our contemporary before reading the able editorial contained in the number of December 28th, where we see that their aim in allowing these publications was rather designed to set forth the part that each discoverer and inventor has played which truly belongs to him than to raise one at the expense of the other. The history of the electro-magnetic telegraph in this country is indissolubly connected with the three names of Henry, Morse and Vail. Henry discovered the proper connection of the magnet and battery necessary to make the sounder act; Vail undoubtedly developed much of the mechaneal contrivances while to Morse belongs the great honor of devising a practical alphabet and using an indomitable energy in carrying out the completed system. Morse's work would perhaps have been beyond his powers without

the assistance of the other two, but to neither of the others belongs the honor of the introduction of the telegraph and its practical application as it does to Professor Morse. The history of this great invention is as the history of all other applications of important discoveries, to no one man belongs the whole thanks of the world for his invention; without the work of those before him and the aid of his contemporaries he cannot carry to complete success any great system, while at the same time the honor of completing the system and making it available for man's use is sufficiently great to make his laurels everlasting.

TRANSFORMER LEAKAGE.

In the "Electrical Engineer" of December 25th we notice an article on the loss of revenue due to transformer leakage current by S. S. Armstrong which calls to the attention of every engineer the necessity for a thorough understanding of accurate methods of measurements before too much reliance can be attached to his results. This article points to the advantage in the use of large transformers on account of the reduction of leakage losses and while we do not wish to quarrel with his conclusions but rather to commend to the attention of all managers of alternating stations the results in this paper, a word of caution is necessary concerning the measurements which he advises engineers to make on their transformers. Apparently one might follow Mr. Armstrong's instructions for obtaining a measurement of the electrical energy in an alternating circuit without taking into account the angle of lag between the electro-motive force and current, and should the central station manager neglect this factor the results obtained by him would be largely inaccurate.

REMOVING CARS IN CASE OF FIRE.

The need of some method of quickly running the cars stored in a car-house from the house in case of fire is important, and has led to the adoption of various expedients, of which perhaps the best known is that of having the tracks pitched at a slight grade, so that the cars in case of need can be quickly run out. This involves keeping the brakes continually set, and in certain respects is somewhat inconvenient to construct and use. A new method has recently been patented by one of the employes of the Detroit Railway, of Detroit, Michigan, and is certainly ingenious in conception, says the "Street Railway Journal." The tracks are level, but the trolley wire running over each track is furnished with a cut-out switch located near the exterior of the building. When the cars are left for the night this switch is opened, leaving the trolley line dead, and each controller is put on the first point. In case of fire an employe has simply to turn the switch operating the trolley line over the track, and the cars immediately file out at a slow rate of speed. In case the motors on one car are disabled it is pushed by the one immediately in the rear. When these cars are safely out the switch controlling the trolley line over another track is thrown in, and the cars on that track are safely removed from danger.

Literature.

ELEMENTS OF THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM BY J. J. THOMPSON, M. A., F. R. S., NEW YORK: MACMILLAN & CO.; PP. 510. PRICE, $2.60.

The publication from the able pen of J. J. Thomson of a systematic mathematical treatment of the subject "Electricity and Magnetism," including not only the simpler division of static electricity and constant current actions but also the subject of electro-magnetic induction will be welcomed by all teachers who have felt the need of a complete and accurate work bridging the space between the simple study of phenomena and the more advanced applications to electro-magnetic machinery. Up to the present time this field, which may properly be called the mechanics of electrical action, has been covered in a thorough manner only by the difficult treatises of Maxwell and Gray, both of which are beyond the comprehension of the ordinary student and make use of systems of mathematics in their treatment which can hardly be included in the necessary equipment of an engineer; while on the other hand, the work of Mascart and Joubert does not examine with sufficient completeness the subject of electro magnetic induction and when used as the basis for further study presumes too much upon the independent mathematical ability of the student.

With the exception of these three treatises we have mentioned other authors have gone so far in their attempted simplification of the subject as to avoid the use of the Calculus and in consequence have presented the subject in a manner not only inexact, but confusing to the student who wishes to read some more advanced treatment of alternating current phenomena and allied subjects.

It is not often that we read in an author's preface the statement that no mathematics more advanced than the calculus will be employed in the treatment and yet this statement which is made by Professor Thomson rationally conforms to the present state of development in the study of electricity and magnetism. The student who is expecting to obtain a complete knowledge of the development of electro-magnetic machinery must at the outset face the need for the continued use of calculus treatments as such treatments are to be found in all books which give the systematic theory of the dynamo, the transformer and the alternating line, treatments which will be unintelligible to the student who has not laid a firm foundation in the mathematical treatment of this part of the subject we have called the mechanics of electricity and magnetism. To those equipped with an understanding of quarternions and the system of vectorial analysis there is no doubt but that the treatment of many electro-magnetic problems may be simplified by their use but up to the present time such methods are not available to any except the most advanced investigators; while the system of the calculus is at the present time within the grasp of all educated engineers.

Being a strictly mathematical treatise, Professor Thomson develops electric, magnetic and electro-magnetic actions from the laws of Gauss, Ampere and Lentz; deriving electro-magnetic induction from the equations of energy as should properly be done rather than in the ordinary roundabout manner from experimental knowledge and advanced mathematical deductions. In treating the magnetic field of force about the magnet and a current Professor Thomson does not hesitate to proceed by the exact method which necessitates three-dimensional equations and here will be found a difficulty in the path of students whose mechanics have been confined to the plane. This action calls for an advance in the treatment of such subjects beyond that given in most of our engineering schools and colleges. Electrical engineers feel this need more distinctly than any others while the exactness and elegance of three-dimensional treatment will be found to compensate for the slight increase in the difficulty of the treatment.

Without particularizing at all we believe that we have pointed out a distinct advance Professor Thomson has made in this elementary mathematical treatise and we wish to emphasize that the study of the book will equip students for a more ready handling of energy equations and for following the advances in either electro-magnetic research or its application to modern electro-magnetic machinery.

Electrical Experiments, by G. E. Bonney. New York: Macmillan & Co.; 250 pp. Price, 75 cents.

In the preface of this "Manual of Instructive Amusement" the author has thrown out a suggestion worthy of considerable enlargement and in light of which his work may be criticised though with the understanding that the plane of criticism is far higher than any intent of the author when undertaking his book originally. In the preface, while enumerating a considerable list of books needful for the complete study of the subjects he is taking up in this manual, the author says: "When the cost of books and instruments is likely to exceed the means of any one experimenter it will be advisable for several persons to form a club or class for amusement and purchase the books and material from the common fund to which all subscribe; clergymen, schoolmasters the youth in our country districts could do service by organizing such clubs." When we read this advice for the proper carrying out of his experiments for amusement it immediately occurs to our mind that throughout the land not only in the country districts but also in the cities are already many clubs formed for the instructive amusement of poor boys and from what we know of the operation of such clubs it would seem that the suggestions of Mr. Bonney might come as a great relief to their managers who are often racking their brains for entertainment that will sufficiently amuse and keep the attention of their charges. Nothing has ever proved to be more wonderful to the boy whether young or old than the mysterious attraction of a magnet for pieces of iron or the curious alternative attraction and repulsion of fine particles to an electrified rod. Founding a course of amusement upon these simple phenomena it is generally easy enough to excite enough interest for the investigation of the phenomena to be undertaken by the student and even to make one who approaches these experiments from the side of amusement merely to become quickly imbued with a desire for becoming a student where a studious disposition in all other lines is entirely lacking. Much good has been done in such clubs for many years past by the various Agassiz associations fostering an interest in studies in natural history, but unfortunately such studies do not appeal to all nor can they be readily carried on during the long winter evenings and away from fields and flowers until considerable advance in the studies themselves have been made, disadvantages which are not attached to the studies of physical effects and especially those belonging to the elements of electricity and magnetism. Without preliminary instruction in such amusements it is generally found that the leader himself is soon at a loss for further lines of instruction and amusement and in such a contingency this book of Mr. Bonney's is eminently adapted to supply directing hints.

A criticism of the book itself as a means of instruction rather than amusement would point to some very serious defects in the treatment especially where he undertakes to carry an understanding of the subject far beyond the effects pointed out by his experiments, as for instance, where he attempts to explain the relation between electricity and magnetism by reference to Sprague's curious analogy of light polarization. In a few cases his statements are absolutely at variance with the results which might be observed, referring as he does to magnetizing one-half of a steel bar at a time by a single touch as though one end of the bar could be magnetized without affecting the other. When he attempts to explain magnetic saturation there is a hopeless confusion between amperes and ampere turns, but as we have said in the beginning a criticism of this book as a manual for exact instruction places it on a higher plane than ever intended by the author. The experiments described when considered as a means for amusement from which instruction may not be eliminated are in the main simple and of such a character that they may be carried out by any one having a common school knowledge of physical phenomena, though in some cases he attempts to make even this branch too complete for the ordinary experimentor since the magnets necessary for the demonstration of dia-magnetic polarity can rarely be found even within the means of a club unless they are willing to expend a very considerable amount of money. Some would perhaps be daunted by the prices he places upon the apparatus necessary for his experiments and it would have much advanced the applicability of the book had he given rough sketches of the appartus that might be home made, though from the pictures one with a little skill in mechincs could easily supply these deficiencies. On the whole, the course of amusement if faithfully carried out will undoubtedly advance the knowledge as

well as the interest in such matters of any club which would be wise enough to undertake to follow this book and we hope that the suggestion thrown out may be taken advantage of by the managers of boys' clubs throughout the country.

CATALOGUE OF THE HOPKINS RAILWAY LIBRARY, by FREDERICK J. TEGGART, B. A. Published by the library of the Leland Stanford Junior University; pp. 225.

We have before us a remarkable catalogue which forms in itself almost a monograph upon railroad literature describing as it does one of the best collections of railroad literature that has been made up to the present time. The library is one that was commenced by Mr. Timothy Hopkins in San Francisco while treasurer of the Southern Pacific Company and presented by him to the Stanford University in 1892, at which time the collection numbered about 2000 volumes and pamphlets. Fortunately Mr. Hopkins also amply provided for the maintenance and increase of this library with the result that it has been possible to edit so very extensive a catalogue indicating the present condition of this valuable collection.

The classification adopted is one which aims to diminish as far as possile the necessity for cross references and it is found that a system has been adopted which renders the works enumerated surprisingly accessable without the extra labor demanded by an extensive system of cross references, a method more likely to confuse the investigator than to aid him on account of the fact that a cross reference catalogue depends for its value upon the completeness of its subdivision—a quantity variable with every investigator. The system here adopted confines each book or report so far as is possible to the individual railroad upon which it has been used and admits of departments such as economics, law, construction, equipment and operation only in those treatises directed especially towards those subjects. In the main the collection has been gathered with reference to standard steam railroads and in this field it is remarkably complete, though it cannot be claimed to be nearly final except in the railroads of the United States and particularly those of the Pacific Slope to which more than thirteen pages are devoted. The primary attention to standard steam roads is especially apparent when we notice that amongst the periodicals and transactions some of the more important street railroad publications are altogether omitted. For instance, no mention is made of the "Street Railroad Gazette" or the "Street Railroad Journal' or of the important street railroad papers presented to the American Institute of Electrical Engineers. In the section especially devoted to electric railroads, Reckenzaun's book on "Electric Traction;" Herring's "Electric Railways" and Martin & Wetzler's "Electric Motors and Their Applications" are not to be found. In some of the subjects treated the absence of papers upon important subjects indicates that insufficient treatment of these subjects have heretofore been undertaken, probably because these subjects were still in their growing state; particularly we notice in this connection a comparative absence of works on signals, on telegraph, and other electric applications. Cableways and cable railroads are mainly represented by trade publications or by historical matter contributed by the early engineers of such means of transportation located on the Pacific Coast from which they had their origin in this country at least.

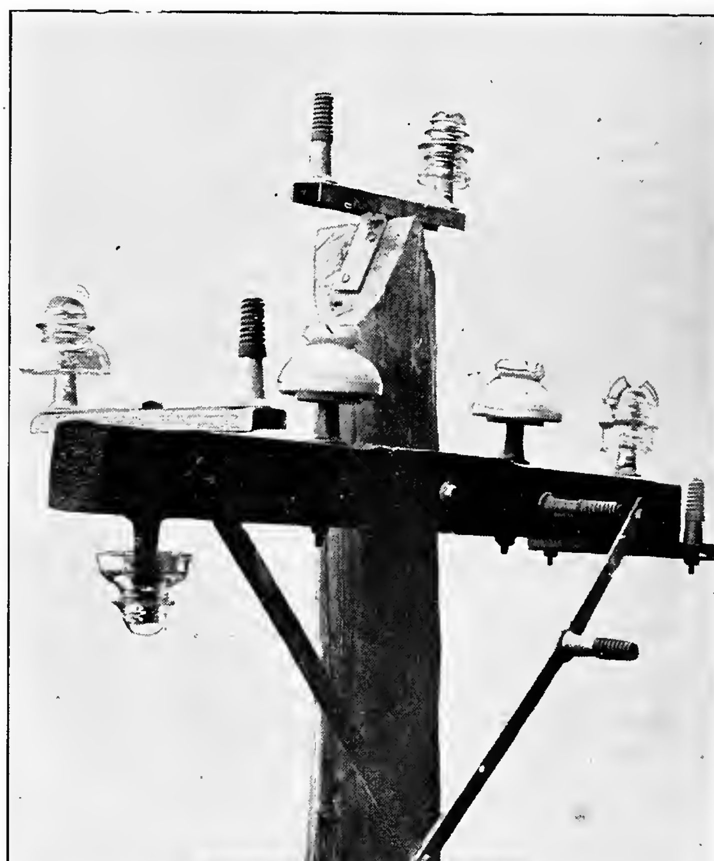
In reviewing this book we are struck in the main with its completeness and with the wide range of subjects treated from which we should judge that the collection is rapidly growing to be most important for the student of any class of railroad problems, whether he is concerned with standard roads in their construction, operation or economical circumstances or whether he is considering the minor fields of tram roads or subsidiary haulages.

The Trade.

In Responding to advertisements in this publication, please mention "The Journal of Electricity."

HIGH GRADE PORCELAIN EQUIPMENTS.

In no department of engineering has it been so fully or so frequently demonstrated that good work and good materials pay, as in the field of electrical transmission



Some of Fred M. Locke's Line Specialties.

and application of power. Cheap devices, like cheap labor, particularly in the field of electrical transmission, not only means a constantly increasing repair account,

but create the probability of failure until such time as the cheaper materials have been replaced by those of the highest quality. An increasing repair account almost invariably forms an unnecessarily large item of expense that makes serious inroads into the dividends of the operating company.

A full appreciation of the fact that the transmission circuits of electrical plants, whether used for the distribution of light or power over long or short distances, form at once the most vulnerable portions of an installation because of their exposure to many trying influences, led Mr. Fred. M. Locke, of Victor, New York, to make special inquiry into the manufacture of strictly high grade appliances, such as pins, brake arms, side brackets, cross arms, special glass and porcelain insulators and other fittings used in pole line construction. This being a day of specialists, it cannot but be admitted that Mr. Locke has brought out a quality of line materials that are unsurpassed. The Locke indestructable steel pin is one that stays where you put it. It does not rot or rust, it is practicably impossible to break it, and it costs but $1.60 per mile of line more than wooden pins.

Then there is the Locke triple petticoat China insulator so extensively used in high potential power transmission circuits. A noteworthy example of the use of this insulator in California is in the Nevada county power transmission at Nevada City and Grass Valley. The insulator measures 5¼ inches in diameter, is 4 inches in height, and, having over twelve inches of surface between the wire contact and the supporting pin, and ten inches of which surface is on the under or dry side, it has been found by repeated practical tests to successfully withstand puncture from a potential of 85,000 volts. The body and glaze of these insulators are of simple earths only, fused together into a vitrious homogeneous mass at the greatest heat, and as no lead or other metallic oxide is used in the making, the glaze is not a conductor. The insulators do not craze or crackle on the surface, as insulators made of inferior material do when subjected to variations of temperature, and, in brief, the superior quality of the materials and workmanship used renders the insulators proof against severe tensile strains or heavy blows, against cracking or chipping from the effects of high potentials, and against the actions of heat, cold, dampness, acids, alkalis or other substances or forces. Being the very best it is the cheapest, though yet inexpensive. Triple petticoat glass insulators designed for currents of 5.000 volts or less, together with special transposition insulators used for the purpose of transposing telephone wires to overcome the effects of induction, are also manufactured, as are railway deep-groove double petticoat insulators, and other insulators of all sizes and designs. The accompanying illustration shows a few of the many high-grade pole line specialties brought out by Fred M. Locke, and among which may be enumerated indestructable steel pins, brake arms, side brackets, glass and porcelain insulators, braces and pole fittings for all classes of line work.

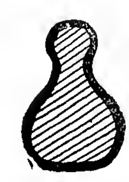
CIRCULAR LOOM CONDUIT FOR THE COAST.

Messrs. J. W. Brooks & Co. of San Francisco, having received the general Western Agency of the American Circular Loom Company of Boston, Mass., are introducing flexible "canvas jacket" conduit on the Pacific Coast that is already meeting with marked success. This conduit is not a new departure, but merely an improved appliance for accomplishing a given and approved result. All conduits, or tubes heretofore furnished for this purpose, have been of a rigid type, connected at short intervals by metal sleeves, and with moulded and rigid elbows. By use of flexible conduits these objectionable points are entirely eliminated, and its flexibility allows of bends of any radius at the will of the constructor. Each "run" may be an entire length; its tightness not depending on the nicety of the fittings of a number of joints or of the carefulness of the constructor.

It is constructed of the best insulating fibre, wound with a heavy Para rubber friction tape; over which is a continuous woven jacket of cotton, similar to that in use in the ordinary cotton garden hose, except that the stitch is much finer, giving it the quality of strong canvas. The whole tube is then saturated with an insulating compound, care being taken that none shall touch the inside fibre, thus leaving the inside of the tube smooth and hard. It is finally run through powdered mica, thus producing a tube which is thoroughly flexible and water-proof and which is highly fireproof. The tubes can be furnished in any lengths, but for convenience are shipped in coils of from 250 to 500 feet, according to diameter. Flexible conduit has passed the rigid inspection of the Underwriters' National Electric Association, and will be found specified under their rules and requirements, dated Octoer 2d, 1893, page 15, Rule 22, as "The American Circular Loom Tube."

THE NANTASKET TROLLEY WIRE.

The Nantasket trolley wire, which was recently brought out by the John A. Roeblings' Sons Co. is of the form shown in outline in the accompanying cut, and the idea prevailing in its manufacture was to design a trolley wire of such shape as would afford a ready means of suspension, at the same time dispensing with the use of trolley clips, which occasion sparking and consequent weakening. The wire is suspended from clips secured to the smaller portion of its cross section, which leaves an uninterrupted smooth surface for the trolley wheel to traverse. The heavy amperages necessary to operate the electrically operated standard railway trains on the Nantasket line made it imperative that more perfect contact between the trolley wheel and wire should be secured, which resulted in the designing of the wire here illustrated. This wire has an area of 330,000 circular mils, or the equivalent of a No. 0000 and a No. 0 wire.

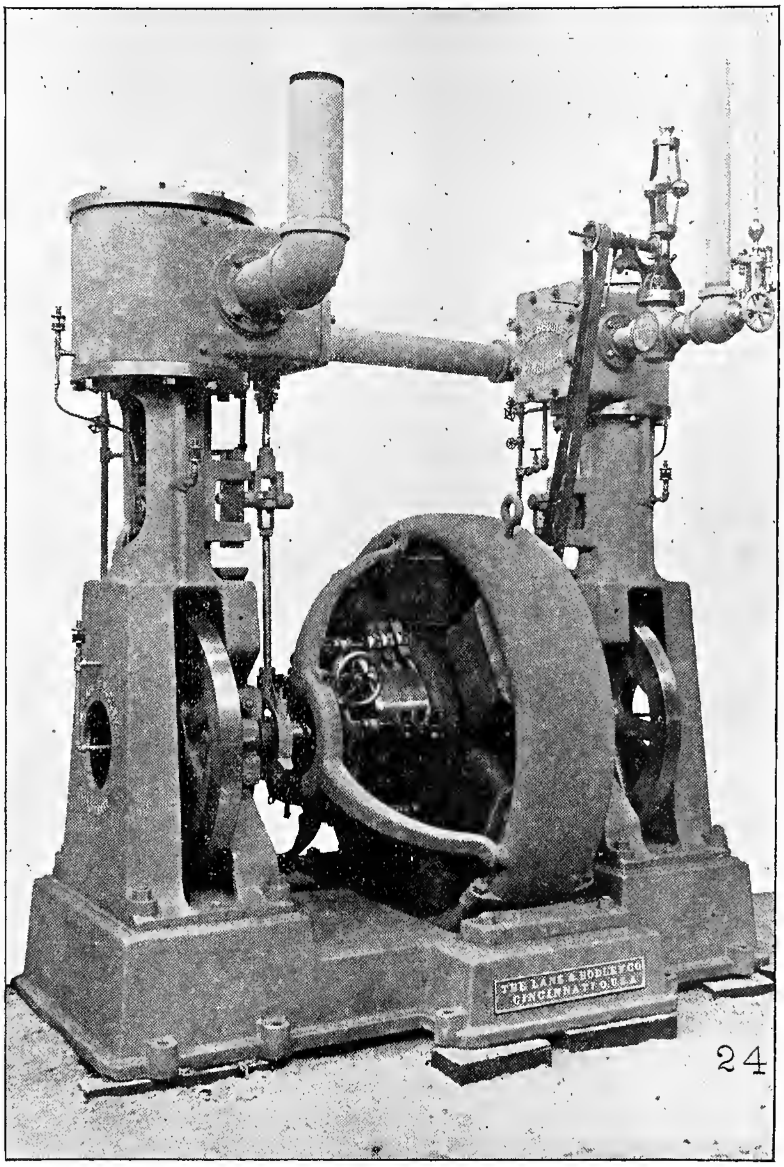


A consideration of the area of the Nantasket trolley wire brings up the suggestion that its use is advisable

over that, for instance of a No 0 trolley wire and a No. 0000 feeder, because no money is invested in insulation of feed wires and the same carrying capacity is secured.

A DIRECT CONNECTED OUTFIT.

During the recent Atlanta Exposition the Card Electric Motor & Dynamo Company, of Mansfield, Ohio, exhibited a new type of direct connected engine and dynamo outfit, which elicited universal commendation.



A Direct Connected Card Dynamo Outfit

The equipment, as illustrated in the accompanying engraving, consisted of a type H multipolar Card generator, driven by a cross-compound Lane & Bodley engine, running at a speed of 275 revolutions per minute.

This combination plant made an enviable record during the Atlanta Exposition, where it was in regular service on other light and power circuits. Messrs. J. W. Brooks & Co. of San Francisco, hold the Pacific Coast agency for the Card apparatus.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

The deposit of salt on the telegraph wires through Utah interferes somewhat with the transmission of news, but it lessens the difficulty of taking the news cum grano salis when it does arrive.—San Francisco Examiner.

"Saginaw Jake," the well-known Killsnoo chief, was in town this week, and for the first time saw electric lights. He at once became infatuated with them, and on being told that the little incandescent ones with a good long "string" attached could be purchased for a dollar, he declared that he would decorate his house with them—they were just what he wanted, but he was puzzled to know how to get inside of the globes to light them.—Juneau, Alaska, Mining Record.

The Douglass mill at this place, which has been lying idle for a number of years, has a splendid water power that might be put to some use in the way of furnishing electricity for light and power in this place, Silver City, Gold Hill and Virginia City. An electric plant could be placed in the mill at a comparatively small cost, and it would not be a very expensive scheme to construct a line of wires from here to Virginia City. This town could be lighted by electricity, and so could the other places along up the canyon at a very small expense. Besides lighting the towns, probably quite a number of small power users would take a line to run their machinery. We believe an enterprise of this kind would pay at this time and if the looked-for better times come this year, we are very sure there would be money in the scheme.—Dayton (Nev.) Times.

The Review-Budget calls attention to the fact that one of the best opportunities in the State for obtaining electric power, and in a cheap way, is just at hand and might be used to our great advantage. This opportunity lies in the water of the Mokelumne river. * * * There is an enormous electric plant being constructed on the north bank of the San Joaquin river, and a great deal of capital is being put into it for the purpose of bringing light and power to Fresno City, and the point of location of the plant is thirty-five miles from Fresno. An electric plant of equal force and of as great power could be placed at Westmoreland's bridge, where the old Mokelumne Ditch Company located its dam, and have a fall of several hundred feet, all that would be required under any circumstances to generate the electric current, and this not twenty miles from Lodi, on a direct line. If a plant were put in there it could supply Stockton and all the neighboring towns with just such power and light as is to be furnished Fresno. —Lodi (Cal.) Valley Review.

The great benefits that would result from the operation of an electric railroad from this city to Clear Lake are readily seen and acknowledged by all. But the introduction of the electric power as proposed by the promoters of this enterprise would prove of vastly greater importance to the future industrial prosperity of Napa than the mere benefits that would follow the operation of a railroad system. Electricity is the power of the future, and the community that neglects to secure its introduction when the opportunity offers will throw away all hope of keeping up in the race of progress. Manufacturing industries of all kinds demand cheap power, and are everywhere seeking localities where such power can be obtained. The present project for transmitting electric power from Clear Lake offers Napa an opportunity for advancement that should not be neglected. Our tide water location makes Napa admirably adapted for manufacturing enterprises, and with the introduction of cheap power her future prosperity would be assured. A conservative estimate places the amount of power now in use in this city and immediate vicinity at 500 horse-power, at a cost of $6 per month for each horse-power—a total of $3,000 per month, or $36,000 a year. Should the project of transmitting electric power from Clear Lake be carried to a successful issue, power can be furnished to these same industries at a rate not to exceed $3 per horse-power per month, a saving of just one-half the present expense. In other words, the advent of electric power would prove a direct saving to the industries at present established in Napa of $18,000 a year, or in ten years the enormous sum of $180,000. Will Napa embrace the opportunity offered by the promoters of this electric project?—Napa (Cal.) Journal.

From present indications it is highly probable that the motive power that will be used in the development of California's manufacturing enterprises in the near future will be electricity. Slowly the electric current is being utilized in place of steam power and the incandescent lamp is supplanting gas. The unparalleled rapidity with which electricity has forced its way into public favor as a motor in industrial enterprises has been productive of a great number of new inventions in machinery and mechanical appliances. This in turn has brought about the establishment of numerous factories for the manufacture of such goods and the creation of mercantile houses for their introduction and sale. New industries are being constantly looked for on the Pacific Coast, which has always been to a considerable extent dependent upon the importation of manufactured goods. In this connection a late discovery is a process of smelting iron by electricity. It is a well known fact that there are immense deposits of mineral in the northern part of the State, where the mountains are rich in iron ore. This could, by Edison's latest process, be converted into a very valuable product. In the immediate vicinity of the ore bodies water power is abundant, the combination forming all that is necessary for the establishment of extensive smelting works. With such a constant and increasing demand as exists on this side of the continent for pig-iron, structural iron and steel, these facts should offer sufficient inducements to enterprising capital if the electric process is as successful in practice as it is in the laboratory.

San Francisco is well up with the spirit of the age, as far as mechanical improvements are concerned. There are numerous manufactories of electric motors and other appliances, besides a number of establishments where the smaller devices and mechanisms of electric science are made and sold. The discovery that a dynamo could be made a motor is scarcely more than a dozen years old, though during that interval such magnificent and wonderful results have been attained as rival those ever achieved in any branch of mechanical art. In this State one of the principal applications of the transmission of power to long distances will no doubt be in the working of mines which have been for a long time past idle owing to the great cost of the necessary power as obtainable by steam. Many of such mines are at a considerable distance from water, but that can now be overcome. The power can be developed at the water supply and transmitted by wire to the plant at the mine or mill, and there be used for any purpose for which steam is available.

As a means of propulsion for street cars electricity is conceded to be not only in all respects the best, but the most economical motive power thus far devised. The enormous power station which furnishes the current for the electric car lines of this city is fitted up with all the latest and most approved machinery that fully meets the requirements demanded of it. Almost all the machinery in this great plant was manufactured in this city. The electric light is coming into general use, and all modern residences are wired for incandescent lighting. The interior cities of the State have not been slow in appreciating the advantages and comparative cheapness of electric light plants as compared with the older methods, and there are few exceptions among the towns of any size where electric light plants have not been established, and in almost all instances the investments have proved profitable to the parties interested.—San Francisco Chronicle.

A company has been formed with a capital stock of $500,000 to erect and put in operation an electric power plant at Horseshoe Bend, Mariposa county. It is announced that power will be generated and transmitted to any reasonable distance, and furnished at a cost of $5 per month per horse power. Thus a small quartz mill requiring ten-horse power could be operated at an expense for power of $50 per month, a less sum than would be paid in wages alone for a steam engine. Then the fuel for a steam engine would cost probably $150 per month. The mine owner would have no engine and boiler to purchase, nothing but his mining machinery. The electric power will permit of the opening of hundreds of ledges in that region which are owned by poor men, and who could not afford to purchase expensive steam appliances. A man can set up a stamp battery and commence working his claim with very little cost. If the ledge did not pay he would not be out any considerable sum. The electrical power proposition is one of the longest strides yet made toward working the hundreds of low grade ledges known to exist to the east and south of us in the Sierra Nevada mountains. The matter is one of vast importance to Stockton. The founderies and other manufactories here are prepared to turn out any and every kind of mining machinery at the lowest possible cost, while the shipping facilities of Stockton are first class.

Reports of the Month.

COMMUNICATION

Astoria, Oregon.—The eight box municipal fire alarm system has been completed.

San Francisco, Cal.—W. J. Martin has been appointed Manager of the San Francisco office of the Western Union Telegraph Co., vice John McRobie, resigned.

Los Angeles, Cal.—The Pacific Coast Telephone and Electric Motor Co., a recent incorporation, proposes to manufacture telephones, under the patents of Frank H. Brown.

Gray's Harbor, Wash.—The Federal Government is to be petitioned by the maritime interests of the Coast to construct a telegraph line from Tatoosh Island south to Gray's Harbor.

Tucson, Ariz.—Chas. F. Hoff of this city proposes to establish about 30 miles of telephone line running from Prescott to Chapparel, to the McCabe mine, to Massic's hydraulics and to Wagnerville. He will also endeavor to connect Phoenix and Prescott, and later to extend the line to make it continuous from Nogales to Flagstaff.

San Jose, Cal.—Messrs. Minor & Chute have erected a line of 55 foot poles on First street for the new telephone company, and are hastening the completion of their contract calling for ——The new telegraph and telephone company has leased the second floor of the Archer building, No. 13 South First street, to be used as the local exchange.

Stockton, Cal.—The Gamewell Fire Alarm and Telegraph Co. through R. A. Rose, Pacific Coast agent, has secured the contract for increasing the efficiency of the fire alarm and police telegraph system in Stockton, which amounts to the practical reconstruction of the entire system.——Work on the telegraph line of the San Joaquin Valley Railroad Co. is being pushed and the poles and wires are up now to a point beyond Burnham.

INCORPORATION.

Redwood City, Cal.—The Redwood Electric Light Co. Directors: J. Geo. Gardner, P. P. Chamberlain, Alex. Gordon, Edward F. Fitzpatrick and Jas. Crowe.

San Francisco.—The Abbott Electric Air Cooling and Purifying Company. Directors: H. W. Abbott, D. Gilbert Depter, A. S. Brackett, Mark Strouse and H. C. Birbee. Capital $1,000,000.

The California Natural Gas, Oil and Land Co. To develop petroleum deposits at Half Moon Bay. Capital stock $1,000,000. Directors: C. F. Sterrett, L. L. James, J. B. McGlew, E. J. Bean and F. M. Smith.

Fresno, Cal.—The Kings River Power Co. Capital stock $300,000, in 3,600 shares of $100 each, of which 1,500 shares have been subscribed by the following Board of Directors: S. F. Earl and the erection of telephone poles throughout the business section. J. S. Jones of Reedly; Jas. Sibley of Dinuba; and W. H. Hammond and Chas. G. Wilcox of Visalia.

San Francisco.—The Mill Valley & Mount Tamalpais Scenic Railway. Not only to build and operate a railway, but also to erect and construct hotels and refreshment houses; operate telegraph and telephone lines, etc., in Marin county, Cal. The road will be eight miles long. The stockholders are: Tamalpais Land and Water Company, A. E. Kent, S. B. Cushing, Arthur A. Martin, William MacCann, M. M. O'Shaughnessy, William C. Savage, Cornelius Toohy, W. C. B. de Fremery, David McKay and Charles C. Green. The capital stock is $200,000, of which $45,600 has been subscribed.——The Gerlach Wave Motor Development Company. Board of Directors: M. A. Rothschild, Pres.; Fred Hilbert, Vice Pres.; M. Feintuch, Sec'y and Treas.; B. D. Pike, E. Gerlach, Manager.

LITIGATION.

Tacoma, Wash.—The city of Tacoma has been awarded a verdict of 787,500 damages against the Tacoma Light & Water Co. for alleged misrepresentation and fraud resulting in the city's purchase of the water and electric light plants in 1893 for $1,750,000.

Santa Cruz, Cal.—Difficulties regarding the management of the Santa Cruz Electric Light & Power Co. have resulted in the bringing of several actions in the Court of various natures, among which may be named a suit to cause the removal of a director, to recover commission for services rendered, and to determine the legality of certain stock issued.

San Diego, Cal.—Isabella K. Stafford has sued the Western Union Telegraph Co. for $11,000 damages for the alleged non-delivery of a telegram. Complainant alleges that owing to the neglect of the company to deliver a telegram announcing the arrival of her mother, who was ill, and requesting Edward F. Kimball to meet them at the depot, in searching for the residence of said Kimball the mother was exposed to cold and inclement weather, from the effects of which she died.

San Francisco, Cal.—Judge Seawell has rendered a decision in effect that the Sunnyside Construction Co. was the accredited agent of the San Francisco and San Mateo Railroad Co.,

and the acts of the former were directed by the latter and consequently legal. The Court sustained the validity of the bonds issued, and ordered that as soon as a final decree should be signed the railroad should be sold and the proceeds applied to defray the costs of the suit, to pay the expenses of the receiver, and to liquidate preferred claims. By this decision the eight miles of double track electric road extending from Market and Steuart streets into San Mateo county passes from the hands of the Joosts. The case will probably be appealed to the Supreme Court.

TRANSMISSION.

Los Angeles, Cal.—The Kern River & Los Angeles Electric Power Co. has accepted an ordinance granting it the right to build and operate transmission circuits along prescribed routes in the county.

Spokane, Wash.—Wm. Nelson states that within 90 days work will begin on the construction of a new flour mill containing a plant for furnishing electric power, together with a smelter and reducing works.

City of Mexico, Mex.—Mr. J. Sternfield has placed orders in San Francisco for a Girard water wheel and a 100 kw. Westinghouse 2-phase generator, to be direct coupled and used for mining transmission purposes.

Santa Cruz, Cal.—The Big Creek Electric Power & Water Co. have given the contract for 300,000 feet of logs for building the proposed transmission plant to Logan, Thurber & Makinney, the contract to be completed by July 25th.

Mariposa, Cal.—The Board of Supervisors has adopted resolutions of congratulation to H. H. Clark of the Bend Power Company for his enterprise in developing and promoting the transmission project of the Bend Power Co.

Salt Lake City, Utah.—The power house of the Big Cottonwood Power Co. at the mouth of Big Cottonwood Canyon, is finished and machinery foundations are being erected. Fourteen miles of 60-foot cedar poles from Sand Point, Idaho, have been erected and linemen are now stringing the 12 wires constituting the circuit from the power house to this city.

Bakersfield, Cal.—The Supervisors of Kern Co. have given permission to the Kern River & Los Angeles Electric Power Co. to erect transmission circuits over the highways of the county.——The plans of the Power Development Co. are now matured, all money necessary has been secured, and specifications have been isued for the building of the plant. Chas. N. Beal is Manager.

San Bernardino, Cal.—The Board of Trustees have inspected the site of the proposed electric power house on Lytle Creek, 16 miles distant, and if the proposed plant can be installed at a reasonable expense, it is probable that the question of issuing bonds for a municipal lighting plant will be placed before the people at a special election at an early date. J. C. Christy, one of the owners of the water right, appears foremost in the transaction.

Sacramento, Cal.—A Tesla 5 horse-power motor has been installed in F. H. Veach's machine shop.——Dr. Van Norden, representing the Central California Electric Co., principally owned by the South Yuba Water Co., has stated to the Board of Trustees that the company has expended over $25,000 on its transmission circuits which were rapidly approaching Sacramento. The length of transmission is 29 miles, and pole line circuits would only be continued to the lettered streets of the city, all other distribution being through underground conduit.

Auburn, Cal.—Walter S. Davis is to take power from the north fork of the American River, seven miles distant, and will operate thereby a 26 inch Girard water wheel to run under a 400 foot head. This wheel, which has a capacity of 300 horse power, will be directly connected to a 150 horse power Electrical Engineering Co.'s D. C. dynamo, whence the power will be transmitted to the Davis mining properties three-quarters of a mile distant, and will be used for various purposes, including the operating of centrifugal pumps and hoists. The order for the machinery has been given to the Girard Water Wheel Co. and the Electrical Engineering Co. of San Francisco.

Visalia, Cal.—The Kings River Power Co. propose to build a power ditch four miles in length to divert water out of Kings River above Mill Creek, by means of which 3,000 horse power can be developed, at a head of 541 feet in the first mile of ditch. It is proposed to transmit electric power to Sanger, a distance of 11 miles, and to Fresno, 26 miles. It is reported that Jesse Grant of San Diego, the son of General Grant, is interested in the project. One of the chief enterprises contemplated by the company is pumping water for irrigating lands near the hills too elevated to be reached by gravity canals. Among other towns named as probable markets for power are Reedly, 12 miles distant, Selma, 22 miles, Fowler, 22 miles, Kingsburg, 21 miles, Traver, 23 miles, Dinuba, 18 miles, and Visalia, 28 miles.

ILLUMINATION.

South Bend, Wash.—Electric lights are to be put in the South Bend saw mill.

Ferndale, Cal.—Nelson & Kerri are in the market for 100 32-foot electric light poles.

Santa Monica, Cal.—The Board of Trustees has advertised for bids for a gas franchise.

Chehalis, Wash.—Ole Rung has been appointed City Electrician, vice Geo. Baldwin, resigned.

Stella, Wash.—Gus Herring will probably erect an arc lighting plant, to be run by water power.

Woodland, Cal.—The electric plant of the Woodland Gas & Electric Light Co. will soon be enlarged.

Orland, Cal.—The Board of Supervisors are to consider plans for a gas lighting plant for the Court House.

Sonora, Cal.—Eugene D. N. Lehe, of Stockton, is installing an incandescent plant in the Rawhide mine.

Junction City, Or.—Robert Clow and associates have been granted a 30 year franchise for an electric light plant.

Nevada City, Cal.—The Nevada County Electric Power Company is installing 10 constant potential Upton arc lamps.

Pomona, Cal.—The San Antonio Electric Light & Power Co. has secured the annual contract for municipal arc lighting.

Butte, Mont.—The Castner Coal and Coke Company is drafting plans for a $22,000 electric light plant, to be erected at Belt.

Redwood City, Cal.—J. Geo. Gardner has purchased an additional 60-kilowatt alternator for the Redwood Electric Light Co.

St. Helena, Cal.—The Gas Company has built an extension to its gas house, in which is being installed a Van Sickle gas generator.

Oakland, Cal.—D. E. Martin has been elected President of the Oakland Gas Light & Heat Co., succeeding the late John W. Coleman.

Grass Valley, Cal.—John Glasson has increased his electric light plant by the addition of a 175 kilowatt Westinghouse alternator.

San Francisco, Cal.—An incandescent lighting plant costing $2,960 is being installed on the revenue cutter "Rush" by the General Electric Co.

La Grande, Or.—Geo. Mayer of Portland has finished the installation of an arc lighting plant for the Grande Ronde Placer Mining Co.

Morenei, Ariz.—L. C. Trent & Co. of Salt Lake City have secured the contract for an electric light and power plant for Wm. Church's mine.

Colusa, Cal.—The proposition of bonding the town to buy or build its own water works and electric light plant is meeting with general favor.

Santa Barbara, Cal.—The Santa Barbara Gas Co. has already expended over $50,000 in the construction of its new gas plant, now nearly completed.

Santa Monica, Cal.—The new Siemens-Halske plant at the Soldiers' Home is now in operation, and the use of 220-volt incandescent lamps is a success.

Haywards, Cal.—Lightning struck the plant of the Haywards Electric Light Co. on January 25th, burning out the dynamos and throwing the city in darkness.

San Leandro, Cal.—The Board of Trustees will receive bids until February 4th for the construction of the electric light plant, for which $10,000 has been voted.

Santa Monica, Cal.—The Santa Monica Electric & Power Co. has erected a new 150 horse power boiler, engine and incandescent dynamo. J. J. Davis is Manager.

Los Gatos, Cal.—It is understood that F. G. Hume of Glen Una ranch, will endeavor to secure the contract for city lighting, and if he does will erect an electric light station.

Colfax, Wash.—The Colfax Electric Light & Power Co., by W. J. Hamilton, President, proposes to light the city with arc lamps for $12 per month per lamp for all night lighting.

Pasadena, Cal.—The San Francisco office of the Fort Wayne Electric Corporation has sold a 1,000 light Wood alternator, equipped complete, including transformers, to E. C. Wright.

Nevada City, Cal.—K. Casper is grading a lot on Commercial street preparatory to the erection of his new electric light plant. The station will be run by water power from the Yuba flume.

Roslyn, Wash.—An interest in the electric light plant has been sold for taxes to Ellensburgh parties, who will probably acquire the remaining portion and start up the plant in the spring.

Canyon City, Or.—An electric light plant for this city and for the town of John Day, two miles distant, is talked of, and if installed, the Humboldt Placer mine will be a consumer during the mining season.

Santa Cruz, Cal.—Clarence E. Lane has resigned the electricianship of the Santa Cruz Electric Light & Power Co., and will hereafter be associated with F. W. Swanton's transmission projects in a similar capacity.

Salt Lake City, Utah.—O. B. Hardy has turned over his electric franchise for Bingham to the Salt Lake & Ogden Gas & Electric Light Co., which will at once string wires from this place to Bingham and light the town.

Riverside, Cal.—Bids on the amended specifications for the municipal lighting plant have been received from the California Electrical Works of San Francisco for $40,978, and from the General Electric Co. for $39,750. Action deferred.

Alameda, Cal.—The City Electrician has prepared specifications calling for bids for one 250 kw. 2,200 volt A. C. dynamo of 7,200 alternations per minute, together with full switchboard equipment. New engines and boilers are also required.

San Mateo, Cal.—The San Mateo Electric Light Co. has been granted permission to erect poles and wires along the county road north to Millbrae, and south to Belmont. A similar privilege has been granted to J. Geo. Gardner of the Redwood Electric Light Co.

Auburn, Cal.—The California Interior Development Co. has purchased a 12-inch Alcott turbine to run under 24 foot head from the Electrical Engineering Co., agents, San Francisco. This turbine will operate a Thomson-Houston arc dynamo for mine lighting.

San Francisco.—An additional 80-light Wood arc dynamo, together with 35 lamps, has been sold to the Mutual Electric Light Co.——The arc lighting of the new Parrott building will be accomplished by 100 Manhattan and about 300 general incandescent arc lamps, all on constant potential circuits.

Spokane, Wash.—Four pairs of horizontal shaft Leffel wheels have been purchased for the Citizens' Electric Light Co., each of which pairs will connect direct to 550 horse power generators.——Idaho Falls is to vote on the proposition to issue bonds for $30,000 for the purchase or erection of water works and an electric light system.

Seattle, Wash.—The Seattle Electric and Gas Fixture Co. is installing a 20 horse power 500-volt generator in the University of Washington, which has also purchased one 2 horse power multipolar 500-volt motor, and one 2 horse power multipolar 125-volt generator for use in its Electrical Engineering Department, all being of Westinghouse manufacture.

City of Mexico, Mex.—The eight year franchise of the Mexico Gas & Electric Light Co. expires on May 8th next, when the corporation, under the terms of the contract, is entitled to buy the plant. The city government has requested S. B. Knight, Manager, to render an estimate of the value of the plant by February 1st, which seems to lend probability to the belief that public lighting will become a regular municipal service.

Dillon, Mont.—The new plant of the Dillon Electric Light Co. is now in operation. The power house is 1½ miles distant, where water power is available, from which is operated a 45 kw. 2-phase Westinghouse generator, delivering current at 1,100

volts, for operating arc and incandescent lamps and delivering power in Dillon. The plant is owned by Mathew Orr, and the entire installation was made by the Montana Electric Co. of Butte City.

Anaconda, Mont.—The Anaconda Co. has ordered Leffel turbine wheels to operate two new dynamos that are to be installed in its electric plant.

Riverside, Cal.—C. B. Hughes and associates have filed a water claim for a continuous flow of 1,500 inches of water at Miller's Narrows on Lytle Creek, where a head of 700 feet can be developed for electric transmission purposes.

Guadalajara, Mexico.—Manuel and Miguel Quevedo have secured a concession for the exclusive right to use the water power of the Rio Grande de Santiago falls for two kilometers below the bridge Tolotlan for the development and transmission of electric power to this city and neighboring towns.

Vancouver, B. C.—The Western Electric Light & Heat Co. have ordered 16,000 poles for their new plant. The power house will be built on False Creek, and local distribution will be effected at 2,200 volts A. C., interior circuits being operated at 50 volts.

Berkeley, Cal.—The Berkeley Electric Lighting Co. has secured the contract for constructing the lighting and power circuits of the State University grounds.——The Oakland Gas Light and Heat Co. has secured control of the Berkeley Electric Light Co., which has been reorganized with J. A. Britton as President. It is understood that the two companies will not be affiliated, however, and that the Berkeley corporation will continue to operate its own plant.

Stockton, Cal.—The City Council has adopted a resolution of intention to advertise for bids for lighting this city by electricity, in the following manner: First—For lighting the city, the bidder to furnish all poles, dynamos, lamps, and all machinery, etc., necessary for the proper lighting of the city. Second—For lighting the city as specified, the bidder to furnish everything necessary for the proper lighting of the city, with the exception of the poles, which the city will furnish and place.

Napa, Cal.—Officers of the Napa City Gas Light & Heat Co. have been elected as follows: Geo. E. Goodman, President; H. P. Goodman, Secretary; J. H. Goodman & Co.'s Bank, Treasurer; and T. R. Parker, Manager.——The Napa Thomson-Houston Light Co., owned by the General Electric Co., has recently been enlarged by a 200 horse power Ball cross-compound engine, and 150 horse power in boilers. The company at present operates 40 street and 16 commercial arcs and 700 incandescent lamps. H. E. Brandt is Superintendent.

San Francisco, Cal.—The San Francisco Gaslight Company, at its annual meeting re-elected the old directors, as follows: Joseph B. Crockett, Adam Grant, Geo. W. Prescott, Levi Strauss, A. H. Payson, Daniel T. Murphy, J. Downey Harvey. The financial statement showed gross assets amounting to $8,729,501.81, and total liabilities of $144,341.23, making total net assets of $8,585,160.58. The number of consumers increased 671 during the past year, and there was an increase of 50 per cent in the number of gas stoves and engines put in use. The Company will probably move its offices from First and Howard streets to the old Young Men's Christian Association building on Sutter street.——J. W. Brooks & Co. report that universal incandescent lamps are to be used throughout the San Francisco Safe Deposit building.

The Ryder street railway car, operated by compressed air, has been under test at the foot of Lombard street.

San Jose, Cal.—Geo. Werner Hoffman, Chief Electrician of the Electric Improvement Co. was killed by electricity on January 11th. Two 60 light arc machines had been coupled together by Hoffman and operated in series, aud in doing this an extension of switchboard circuits was made by coupling two wires together by means of an ordinary brass screw connector, which lay on the floor in front of the switchboard, untaped and unprotected in any way. In starting up the machine Hoffman completed a circuit from a plug in his hand to the bare connector with his shoe, and was instantly stricken. Extraordinary to relate, unconsciousness did not instantly follow, as the testimony of Geo. Johnson, the oiler, at the inquest, shows that conversation ensued between he and Hoffman after the latter received the shock.

Los Angeles, Cal.—The California Electrical Works of San Francisco has secured the contract for wiring the Wilcox building.——E. E. Peck has petitioned the Mayor and Council to advertise for sale an electric light, power and heating franchise in that portion of the city south of Seventh street and west of Main street.——L. B. Pemberton, Consulting Electrical Engineer, has prepared plans and specifications for an isolated arc and incandescent lighting plant for the Los Angeles Ice & Cold Storage Works.——The Los Angeles Edison Light & Power Co. is to install a plant as the General Electric licensees in this city. The plant will have the capacity of 30,000 incandescent and 500 arcs, and will cost approximately $500,000. Chas. R. Lloyd of San Francisco is at the head of the company, which has bought the Lester F. Scott franchise. Work will be commenced within thirty days.

San Bernardino, Cal.—The following bids have been received for 60 or more 2,000 c. p. arc lamps for lighting the city during the ensuing year: San Bernardino Electric Co., $5.90 per lamp per month; Electric Light and Power Co., $7 per lamp per month; San Antonio Electric Light and Power Co., $6.51 per lamp per month. Contract was awarded to the first named——It is announced that Chas. R. Lloyd, President of the San Bernardino Electric Light Co., has succeeded in purchasing the entire plant of the Electric Light & Power Co., excluding only the gas works. This includes the electric station in this city and at East Riverside. Inasmuch as the San Bernardino Electric Light Co. is at present utilizing all the power that can be developed from the irrigation ditch at Kehl's mill, it is possible that the additional power necessary will be secured from the Redlands Light & Power Co.

TRANSPORTATION.

San Jose, Cal.—Popp & Hogan have installed a 500 volt Westinghouse motor.

San Bernardino, Cal.—The horse car system will probably be equipped as an electric line in the spring.

Sacramento, Cal.—The Sacramento, Fair Oaks and Orangevale Railway Company has secured the franchise for which it appneα.

Helena, Mont.—D. B. May, formerly of Billings, is endeavoring to secure a franchise for an electric road in Yellowstone National Park.

Tacoma, Wash.—The Tacoma Railway and Motor Co. is hauling its wood trains by 100 horse power electric locomotive, consisting of a box car equipped with four two-horse power motors.

Ventura, Cal.—Nothing will be done towards building an electric railway between Ventura and Santa Paula until the Ojai Valley railroad scheme is assured. E. S. Thatcher is chairman of the Citizens' Committee having the matter in charge.

Monte Cristo, Wash.—Thos. Imeson, of Seattle, is installing considerable electric mining apparatus in the Monte Cristo mines. The transmission circuits for the Burleigh Rock Drill in the Pride of the Mountain mine are finished, and the electric drills will soon be in operation.

Anaconda, Mont.—The Anaconda Electric Railway & Power Co. is installing five Leffel turbines of 800 horse power to run under a 140 foot head. These turbines are coupled direct to the generators, and one is a triple cascade wheel, each wheel having three nozzles.

Berkeley, Cal.—It is reported that the Oakland Consolidated Street Railway Co. will extend its lines to North and West Berkeley in the spring. The route to North Berkeley will probably be up Oxford street and down Milvia street, while the road to West Berkeley will undoubtedly be along University avenue.

Napa, Cal.—The franchise for an electric railroad through the Napa Valley, granted to L. Grothwell last June has been cancelled because of failure to file a satisfactory bond.——Mass meetings are being held in behalf of the proposition of transmitting power here from Clear Lake, for street railway and other purposes.

Elmhurst, Cal.—The Oakland, San Leandro & Haywards Electric Railway is double-tracking the country divisions of its lines. Fifty-six lbs. English T rails are being used and the overhead equipment is being altered from bracket to span wire suspension.——Experiments are being made at the O. S. L. & H. Electric power-house in the way of increasing the draught by blowing jets of steam through the coals from beneath the grates.

San Jose, Cal.—The total subscriptions to the proposed electric railway from San Jose to Saratoga now amount to $15,000. The Board of Trade has requested L. M. Hale, the local representative of an Eastern syndicate, to petition the Board of Supervisors for the necessary franchise at once. It is hoped that the new line will be in operation during the Rose Carnival in May. Mr. Hale has renewed the proposition to build the road for $200,000, provided $50,000 is subscribed locally.

Los Angeles, Cal.—Francisca A. Jeresun has applied for an electric railway franchise over Fifth and Main streets.——During February The Los Angeles Con. Street Railway Co. will have all its lines operated by electricity.——The Board of Supervisors will receive bids on February 10th for an electric railway franchise for 50 years from Los Angeles to Santa Monica, on petition of E. P. Clark.——The Main Street and Agricultural Park Railway has been sold to the Los Angeles Electric Railway Co.

Oakland, Cal.—The Piedmont & Mountain View Railway Co. has converted seven cable cars into double end electric cars, each having two 40 horse power equipments in addition to the usual cable grip and track brakes. These cars have been run experimentally over the Piedmont Hills division of the road, which has just been equipped with electricity, the maximum grade of which is 14.5 per cent. The heaviest travel is on Sundays, when both the cable and electric systems will operate on the same route, but on week days the trolley alone will be used. ——Certain Oakland capitalists have inaugurated a movement to build an electric road from Lower Lake to Vineyard, 12 miles from Napa. W. H. McKinnon of Oakland and Richard Wylie of Napa are prominent in the scheme. It is proposed to develop power on Cache Creek, Lake county, where 7,500 horse power is available.

Portland, Or.—The Portland General Electric Co. has acquired control of the Union Power Company, which until the present time has been supplying power for all the street railway systems in the city except the lines of the City and Suburban Company. The Union power plant has a capacity of 1,400 horse power, and in all probability it will be supplanted by the use of power transmitted from Oregon City.——The projectors of the First Street Electric Railway contemplate extending the line south from Jefferson street to Grant street, a distance of ten blocks.

Truckee, Cal.—D. B. and C. T. Bliss of Nevada, intend to build a broad-gauge electric road over the Sierras from Truckee to Lake Tahoe, a distance of 16 miles, at a cost of $100,000. Power will be obtained from the outlet of the lake, and it is expected that the line will be finished by June 1st. Elaborate improvements intending to enhance the attractiveness of Lake Tahoe are also being carried out by these parties, prominent among which is the building of a steel passenger steamer costing $70,000. This craft, which is now being built by the Union Iron Works, will have a speed of 23½ knots per hour, and will be fitted with all modern equipments, including electric lights.

San Francisco, Cal.—The Mission street line of the Market Street Railway Co. will soon be extended out Mission road to the county line and also across Sickles avenue to the S. P. depot in Oceanview.——Trial trips have been made over the Sutro road, and its formal opening occurred February 1st. The line starts at the intersection of Central avenue and Geary street, running out Central avenue to California, to Williamson, to Richmond avenue, to First avenue, to Clement street, to 33d avenue, to Point Lobos avenue and Point Lobos road, to 48th avenue, and winding down thence to the Sutro baths near the beach.——The surveys for the Mill Valley and Mt. Tamalpais Scenic Railway have been completed, and plans for the equipment, including the power house, have been prepared by Messrs. W. Stuart-Smith and Sidney Sprout, Consulting and Supervising Electrical Engineers. The power house will be located in Mill Valley, whence the road will continue through Blythdale, then up on the mountain at a maximum gradient of 7½ per cent. Ground on the line will be broken on February 3d. The original intention to construct a cog or cable road has been abandoned and the trolley system alone will be used.

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The Sutro Railroad

The Sutro railroad is popularly believed to have been built as the result of a disagreement between Adolph Sutro and C. P. Huntington over the fact that until the

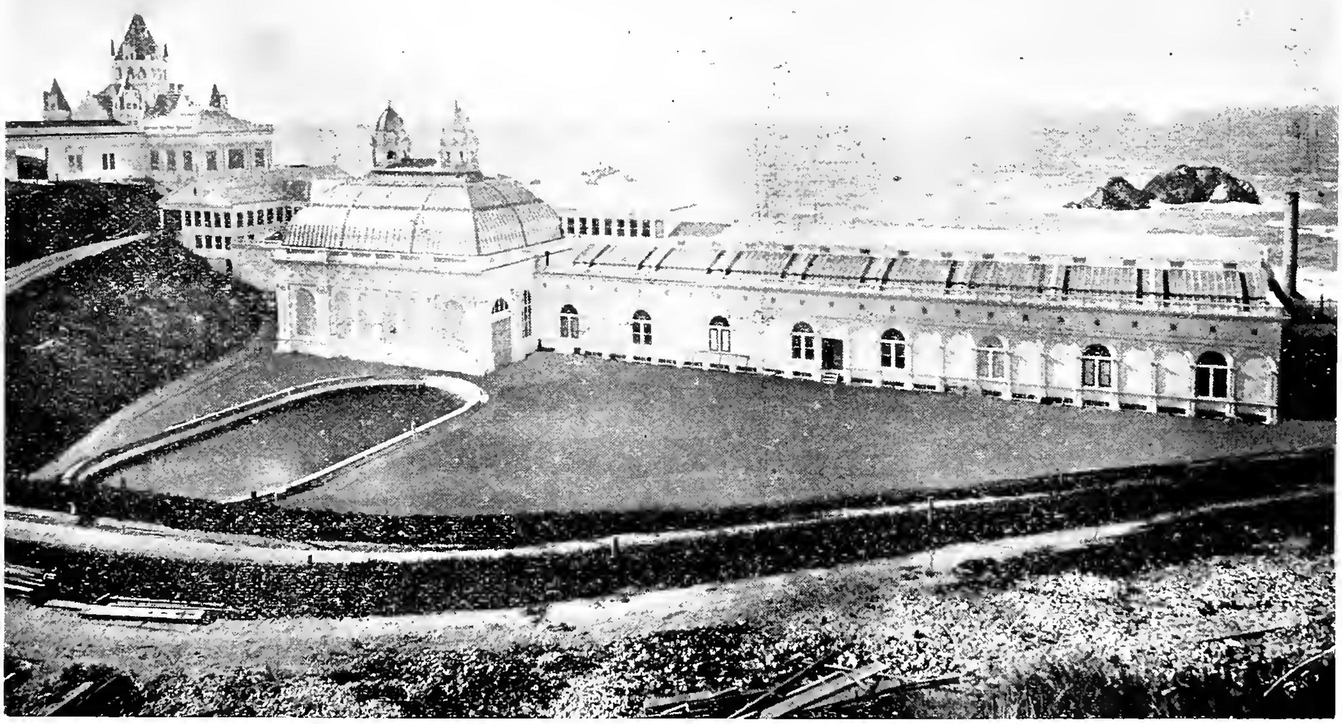


Photo by Taber FIGURE 1—THE GREAT BATHS AS SEEN FROM THE SUTRO RAILROAD.

Sutro railroad became a certainty the street car lines controlled by Mr. Huntington persisted in maintaining a 10-cent fare to the Cliff House. Be this as it may, it is certain that Mr. Sutro had long cherished the idea of securing cheap transportation to the ocean beach with the hope that it might become the Mecca of the thousands whom he believed would appreciate the magnificent baths he had erected and the many other features of interest thereto to be found. Here may be seen, as nature's contribution, the world-famed seal rocks and a marine view that is unsurpassed, while the hand of man has made Sutro Heights a garden of beauty and has wrought novelties and attractions that will amuse every class, whether young or old, rich or poor. The Sutro baths are unequaled anywhere in point of size and magnificence, and while Mr. Sutro has spared neither money or effort in their perfection, he has found time to carry out engineering details of his own conception that prove unique and of great utility.

The power house for the Sutro railroad adjoins the baths and a person standing in its doorway can easily toss a stone into the surf. The water for the baths is secured in a way that is decidedly novel. The baths are

built in a crescent-shaped cove, upon one point of which stands the Cliff House, while the other point is a cape of rocks, perhaps 300 feet from the power house, that stands boldly into the sea. This cap has been tunnelled and its outer portion has been expanded into a basin cut out of the solid rock and of such an elevation above the water that each breaker dashing against the rocks forces its crest up and over the brink into the basin.

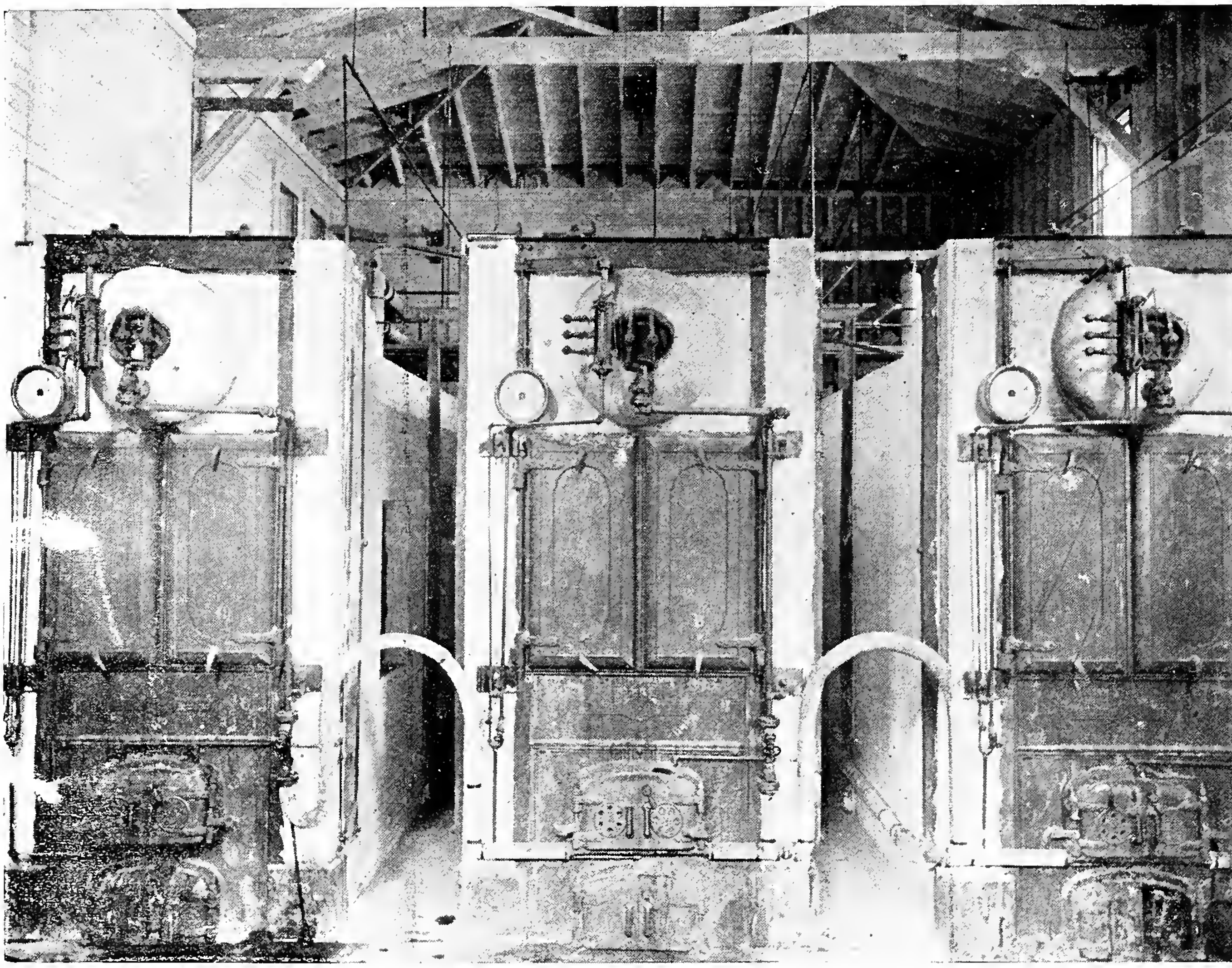


Photo by *Taber* FIGURE 2—BABCOCK & WILCOX BOILERS IN THE SUTRO RAILROAD.

The waves beat against the rocks at this point with unrelenting fury, for the point forms the south side at the entrance of Golden Gate and so heavy is the swell that it is estimated that some waves throw as much as 200,000 cubic yards of water into the catch basin. This water is perfectly clean, but oft times contains sand, to dispose of which the water is carried through the tunnel named and about 150 feet of masonry canals into a settling reservoir, where the sand settles and at low tide is drawn off from the bottom by means of sluice gates placed therein. The catch basin holds the water at an elevaton of twelve feet above high tide, which is sufficient head to supply the baths and allow the latter to be drained at low tide by gravity.

The situation therefore becomes an ideal one for the operation of condensing engines and it was a realization of this fact which led to locating the power house at this site. The gain in using the water thus obtained for condensers is two-fold in that it not only increases the engine efficiency, but that it also warms the water for the baths, and as the water from the catch basin is at a considerable head as stated, it is run by gravity through the condensers into the baths and discharged from the tanks in the same manner.

Considerable interest is awakened in the visitor by the very perfect manner in which the immense swimming tanks in the baths are illuminated. This is done through the use of fifty General Incandescent inverted arc lamps, installed by the Abner Doble Company. These lamps are provided with reflectors and placed over the water at an elevation of about forty feet. The lights cast no shadows and so perfect is the illumination that the seams in the concrete work of the basins are clearly discernable through nine feet of salt water.

The power house contains one 400-kilowatt and one 200-kilowatt General Electric railway generators and

one 75-kilowatt multipolar 125-volt generator for operating the 1,200 incandescent lamps in the baths. These machines are all of the ordinary six-pole type and are driven by suitable verticle compound engines manufactured by the Fulton Engineering and Ship Building Works of San Fracisco. The boilers are fine examples of the Babcock & Wilcox Company's new wrought steel sectional water tube safety boilers, being made of wrought steel throughout, while the steel forgings are simple and ingenious and differ from anything heretofore installed in San Francisco. As shown in the illustration each boiler has an independent setting, thus affording special facility and accessibility for inspection, in addition to which each boiler is perfectly independent of its own brick work, thus preventing the strain of expansion and contraction from being thrown upon the settings. The boilers are capable of withstanding a working pressure of 200 pounds per square inch with perfect safety and are withal of general superiority.

The railway equipment is generally of the Walker type, there being fifteen No. 10 double equipments, each of fifty horsepower. In addition, the Westinghouse Electric and Manufacturing Company has placed six type "12 A" twenty-five-horsepower equipments, while there have also been installed six "G. E. 800s." The Walker motors are all of the spring mounted suspension and series parallel controllers of the familiar forms are used with the exception that the road is to bear the distinction of being the first to be equipped with the new Walker three-barrel controller. The cars are of the double and combination type, and are thirty-seven feet in length over all, and eight feet wide. They are built in a most substantial manner with steel beams and are finished in ash and mahogany and plate glass. These cars are from the W. L. Holman car works of San Francisco and are the most attractive yet seen.

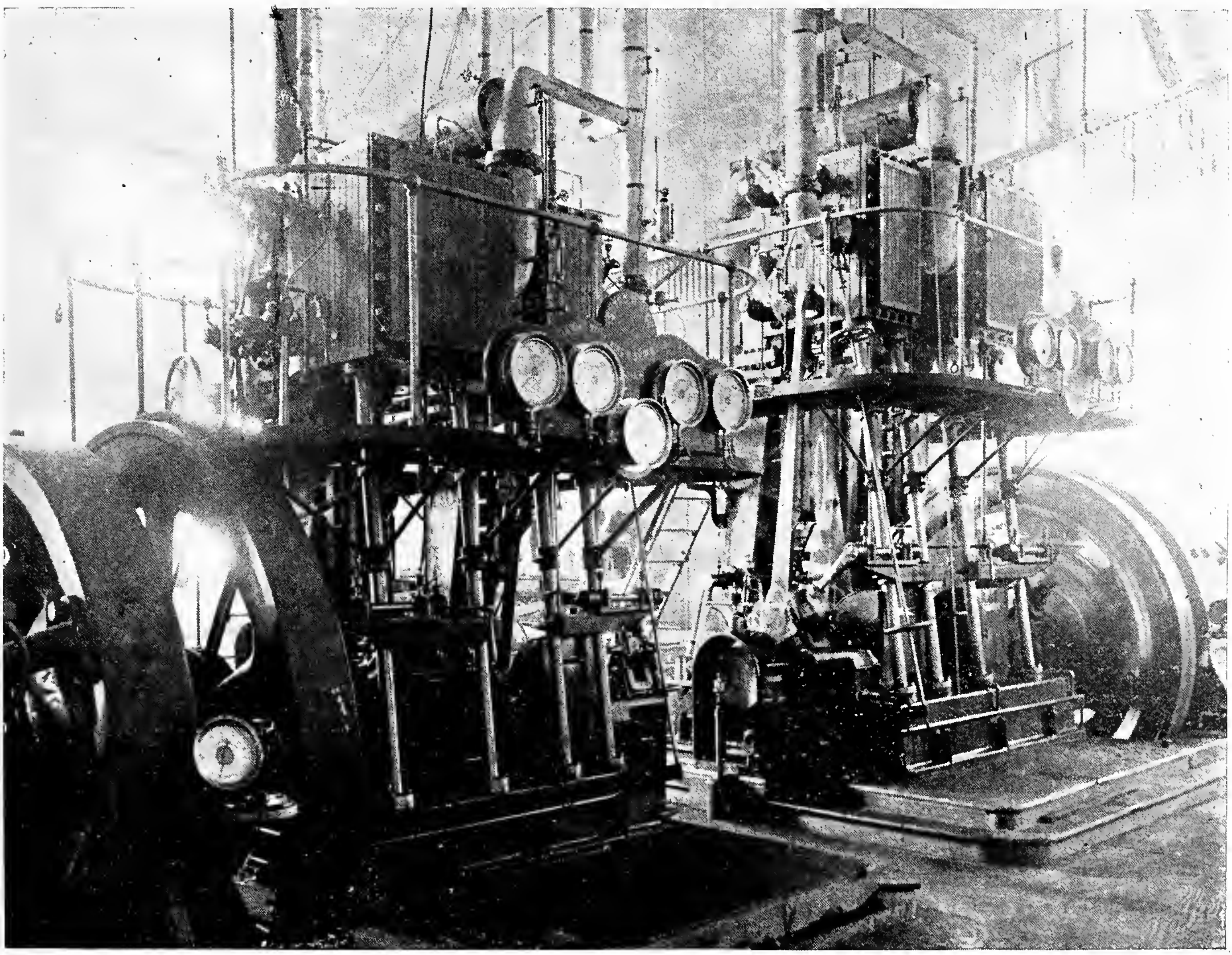


Photo by *Taber.* FIGURE 3—ENGINE ROOM OF THE SUTRO RAILROAD AND BATHS.

The only connection made by the Sutro railroad is that with the Sutter Street Railroad Company, whose cable lines are well distributed over the city. The Sutter street line terminates at Central avenue, where transfers are issued to the Sutro railroad and from this point the electric cars proceed out through Richmond to their destination over a line having a maximum grade of 10.5 per cent. Sixty-five-pound T rails are used

throughout and these are bonded by three laps of No. 00 wire. The track is of standard gauge and is carried on split redwood ties, well ballasted and tamped with crushed basalt rock with which the streets along which the line runs are built. A branch line three-quarters of a mile in length leaves the main line on Clement street and Eighth avenue and continues out the latter thoroughfare to Golden Gate Park, thus affording a park

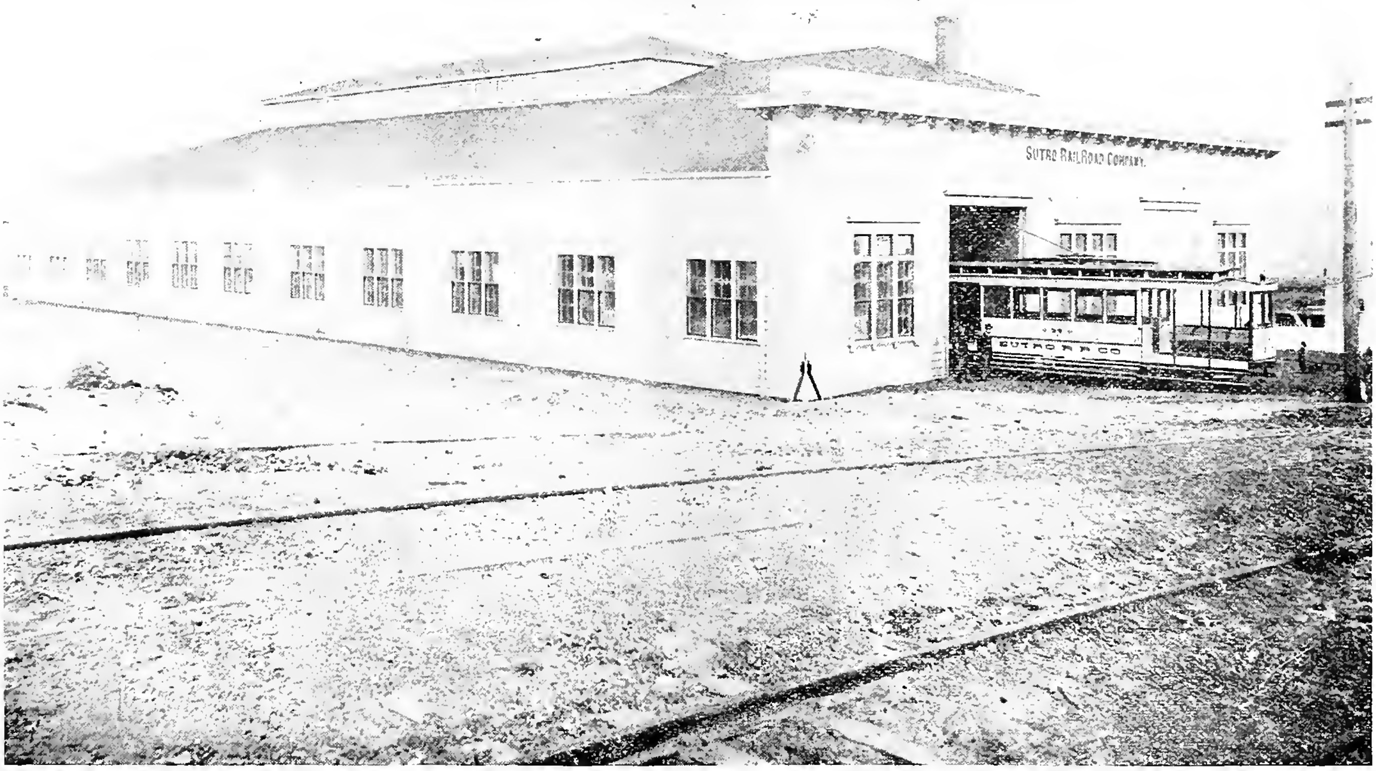


Photo by Taber Figure 4—CAR BARN OF THE SUTRO RAILROAD.

terminus for the Sutter street line.

Those who frequented the California Midwinter International Exposition will recognize many of its attractions at the Cliff House, where may be found the Firth wheel, the mirror maze, the haunted swing and many other novelties of the Midway, all of which have been restored on the open ground above the baths. It is also understood that the electric tower is to be similarly restored at this place, while within the baths the spacious galleries have been filled with choice specimens of natural history that have been gathered by Mr. Sutro's agents in all parts of the world. Every comfort has been provided for guests, even to the extent of building the terminal station of the railway under the roof of the baths and the road throughout evinces careful consideration for the comfort and convenience of its patrons to an extent that is exemplary.

NEW POWER TRANSMISSION PLANTS.

The electrical equipment of the extensive cotton mills of the Pelzer Manufacturing Company, one of the largest cotton goods manufacturing concerns in the south, is rapidly nearing completion. The motive power is derived from Victor turbine water wheels driving 3 750 kilowatt three-phase generators, wound for 3,300 volts. The water wheels turn at a speed of 164 revolutions per minute. The electricity generated at the power house will be carried a distance of three and a half miles to Pelzer, where it will enter the mills and drive the following motors: One 400 horsepower synchronous motor wound for high potential, and three multiphase motors of varying capacities from 5 horsepower up to 110 horsepower. The majority of these motors will be of the inverted type, suspended from the ceiling in the different rooms. They will receive the current at a low potential from step-down transformers placed in the substation at the mills. The mills will also be lighted from the same circuit.

Traction

ELECTRICITY ON THE BROOKLYN BRIDGE.

The first official exhibition of electricity as applied to the switching of the cars on the Brooklyn bridge was made on February 8th. The motor car was coupled to three of the ordinary passenger cars and the train was switched from the incoming to the outgoing platforms and thence to the cable sheaves several times. The car was then taken over the complete bridge circuit twice, and complete satisfaction was expressed at the manner in which the work was performed.

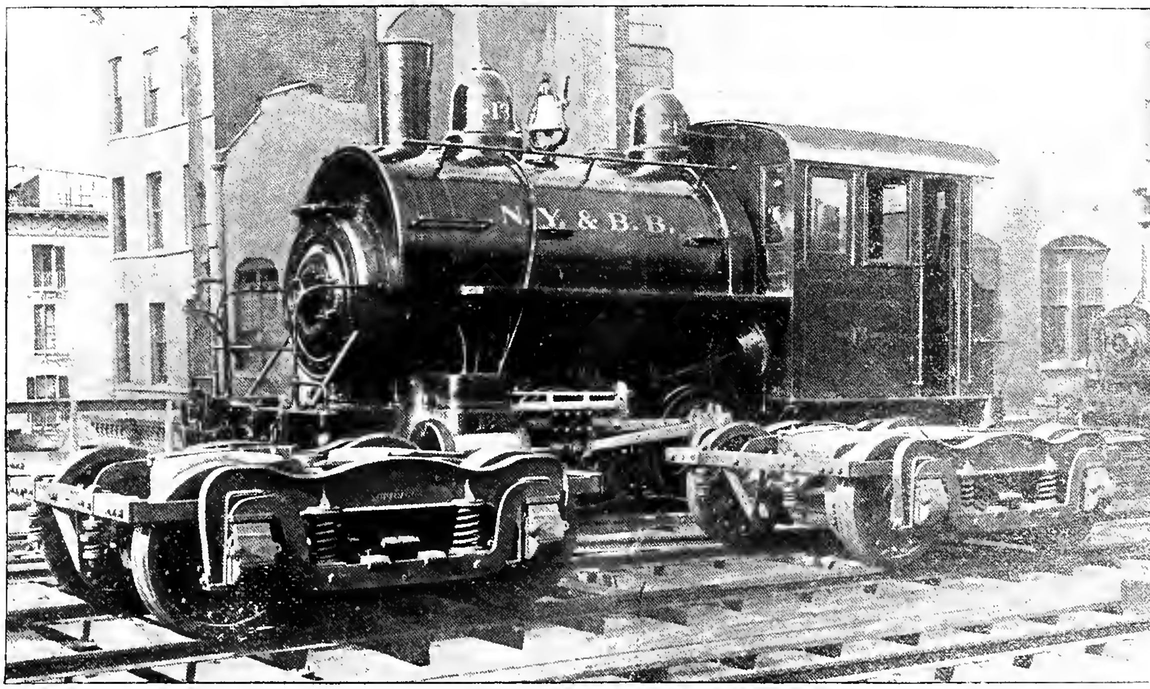


Figure 1—ELECTRICITY ON THE BROOKLYN BRIDGE—THE OLD AND THE NEW LOCOMOTIVES.

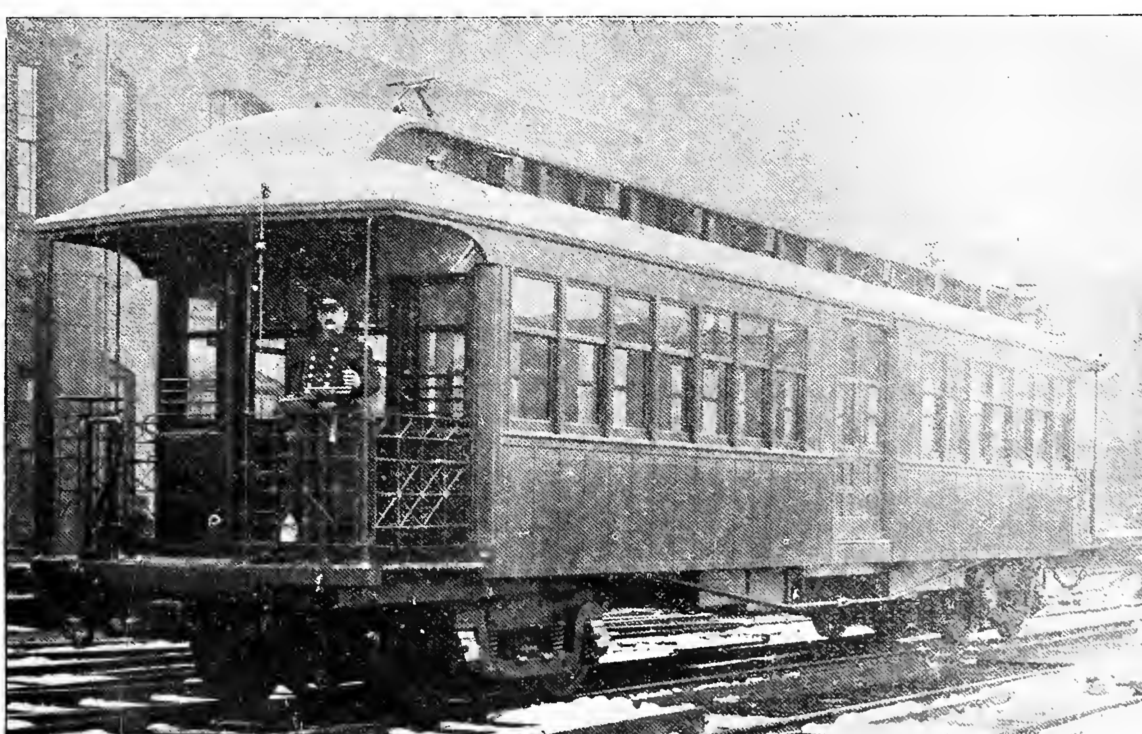


Figure 2—ELECTRICITY ON THE BROOKLYN BRIDGE—THE ELECTRIC MOTOR CAR.

The use of electricity in place of steam for switching the cars at either end of the Brooklyn bridge has been recognized as the only suitable method ever since the electric railway motor became a practical fact. But not until the motor had been adapted to heavy train service and had proved successful on the West Side Elevated road at Chicago, the Nantasket Beach division of the New York, New Haven & Hartford railroad and on the Baltimore & Ohio main line, did its employment in the bridge service become possible. Experiment is not a function of a municipal body, such as that governing the operation of the bridge, consequently it hesitated to apply electricity to bridge traction service, until it was

certain that if applied it would work without a hitch. The Chicago road has been running without a break of any kind since last June, the Nantasket Beach road was operated during the summer without the slightest trouble and the electric locomotives of the B. & O. road have been conducting the entire freight service through the tunnel since the 2d of August last.

To enable the bridge trustees and the engineer the better to judge of the advantages which electric motive power might offer over the steam power hitherto employed for switching service, bids were called for the proposed electrical equipment, to which the General Electric Company responded, offering to fully equip one car, operate it for thirty days and at the end of that time, if the results were not satisfactory, to restore the car to its original condition and bear the cost of the experiment.

If the general plan adopted at first prove economical and satisfactory, a certain number of cars will be equipped with four motors, one on each axle. These motor cars will each remain with its own train at all times, switching it from the incoming to the outgoing tracks and pulling or pushing it over the tilting sheaves when the grips will take up the cable and the motors cease work. Should the grips slip while the train is mounting the 3.78 per cent grade the motors can assist the trains over the summit. Moreover, during the early morning hours, when traffic is light and the cable is not running the trains can be operated entirely by motor cars, as they are now by the steam locomotives. The eventual outcome will probably be the exclusive operation of the Bridge railroad by electric motor cars. Meanwhile they will switch the trains, and as each train is equipped with its own motor car, all the interference which the steam locomotives have hitherto placed in the way of the incoming and outgoing trains will be done away with and the complexity of the switching be greatly reduced. At present the time consumed in switching a train is twenty seconds and in that time a vast number of people gather on the platforms. With the new motor and the new principle of operation it is expected that passengers will at all times have cars waiting for them. Besides the gain in time in the switching process all the noise, smoke, steam and gases of the steam locomotive will be eliminated and this in itself will be no small gain.

One of the regular passenger cars of the Brooklyn Bridge has been selected to receive the first electrical equipment. All appartus, except the controlling handles and circuit breakers will be placed out of sight beneath the floor of the car. The ordinary light Pullman trucks and the cable grip mechanism have been removed, and as heavier trucks were necessary to carry the motors, they were supplied by the McGuire Company of Chicago, which combine the excellent features of passenger and locomotive trucks.

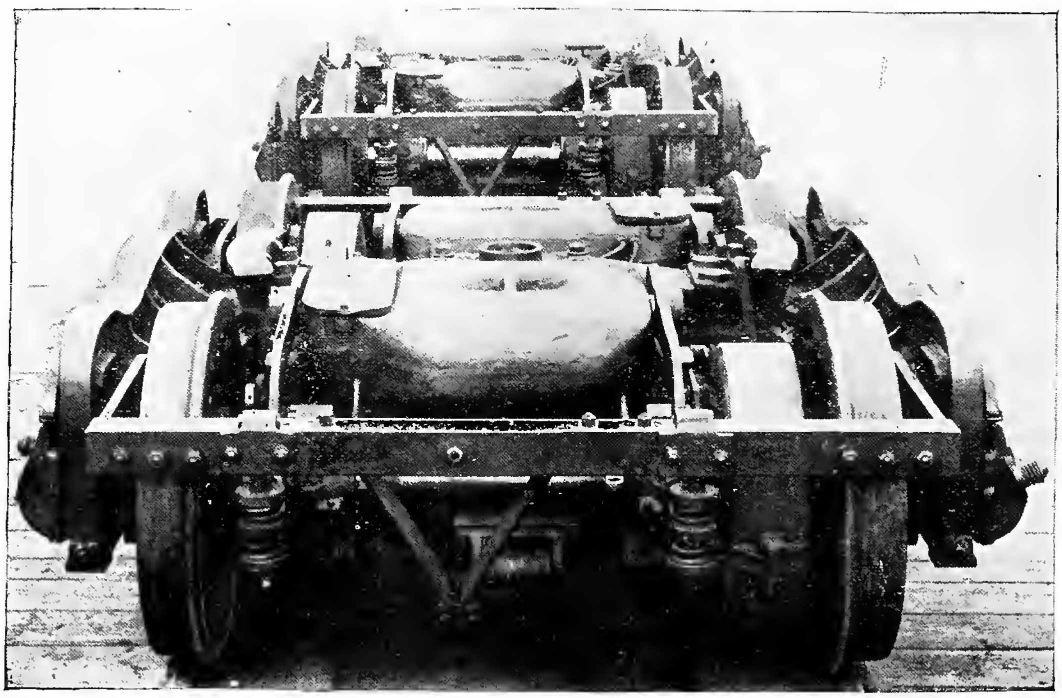


Figure 3—Electricity on the Brooklyn Bridge—Motor and Truck Mountings.

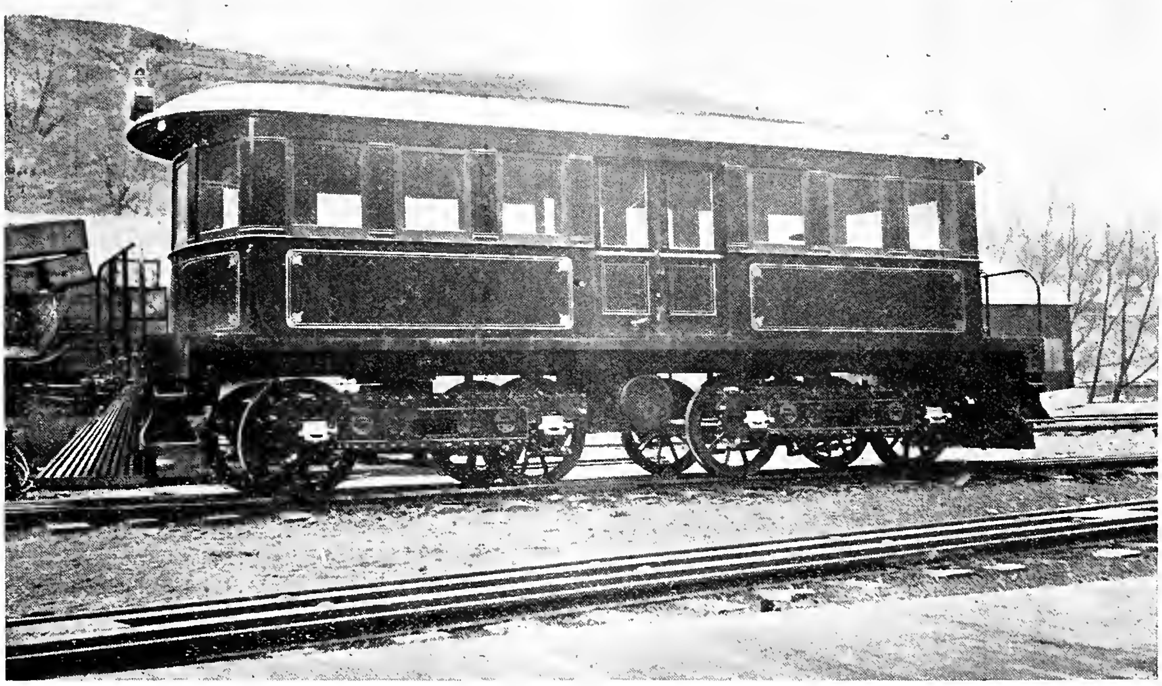
The general character of the motor equipment is similar to that in use on the Chicago Elevated and Nantasket Beach roads above mentioned. The motors are known as the "G. E. 1200," from the fact that under normal conditions each will exert a horizontal draw-bar effort of 1,200 pounds when mounted on a 33-inch wheel. Four of these motors are employed, one to each axle or two to each truck. They are completely incased and are water and dust tight. The armatures are of the well-known iron-clad type, the Eickmeyer windings used being sunk into slots in the armature core, which avoids the crossing of two wires of large difference of potential. The insulation is substantial and each segment of the commutator is of hard drawn copper. The armature is mounted on a sleve keyed to the shaft, which may be withdrawn without interefering with the armature structure. The field frame is of cast steel, and the ratio of reduction between the armature shaft pinion and the wheel gear is 3.5 to 1. Each motor weighs about three thousand pounds. With this equipment and the regular train a speed of about fifteen miles an hour may be obtained. Each motor is suspended on the truck from two trunnions in the upper field set in two bars, the outer ends of the bar

resting on eliptical springs, which relieves the axle of nearly all the weight of the motor. The controllers used are of the L 4 type, which have given such general satisfaction on the Chicago roads. The indicating dial of the controller is placed at the top of the platform rail and is lettered "series," "multiiple" and "off," showing exactly the position of the controller itself. The reversing handle is jointed and can be placed on or taken off the reversing switch spindle only when the controller handle points to the "off" position, showing that there is no current in the motors at that moment. The controller itself has no effect until the long arm of this jointed handle is dropped into the "forward" or "reversing" notches in the reversing handle plate. There are two controllers, each operated from its own platform and either controller will operate the four motors or any two of them as may be desired.

play up and down to conform to the varying heights of the overhead wire. With this collector the trouble of reversing is entirely done away with. The power to run the car will be taken from the overhead wire already in position supplying current to the electric lights in the cars. The extra current, however, will be supplied from Fulton street feeder of the Kent avenue station of the Brooklyn City Railway, the return wire being connected to the rails of the surface road.

THE BALDWIN-WESTINGHOUSE ELECTRIC LOCOMOTIVES.

The Westinghouse Electric and Manufacturing Company has received the first electric locomotive manufactured under the arrangement entered into some time



THE BALDIN-WESTINGHOUSE ELECTRIC LOCOMOTIVES.

The resistance as well as the magnetic cutouts are placed beneath the car floor. Beneath each hood of the car is an automatic circuit breaker, placed within easy reach of the motorman. The operation of this device is instantaneous and is an effectual safeguard against any accident to the motor. Those circuit breakers take the place of the main circuit hood switches, but are wired in multiple with each other instead of in series. To guard against any possibility of one being closed while the motorman is at the other end of the car and desires to open the main circuit, only one handle is provided. The handle cannot be taken off without opening the circuit breaker and when removed the circuit is locked open. As the motorman must take the controller and circiut breaker handles with him when changing ends all danger of complication is avoided.

The collector, which will take the current from the overhead wire is a diamond-shaped frame of metal set longitudinally upon the roof of the car and carrying at right angles a bar in the center of which is a roller. The arms are wide enough to preclude any possility of missing contact. The diamond frame is depressable and expansible on the principle of the pantograph, allowing a

ago between the Westinghouse Company and the Baldwin Locomotive Works of Philadelphia. In appearance the locomotive is much different from the steam locomotive, and it also shows radical departures in construction from every electric locomotive hitherto manufactured. It is thirty-eight feet long and nine feet across. All the operating parts of the locomotive have been placed on the track and the body of the car will only contain controlling apparatus, and can be utilized as a receptacle for such appliances as are usually carried by any train. It may also be used as a freight or baggage car.

One of the characteristic features of the locomtive is the truck, which has eight wheels and is constructed in a very substantial manner. The wheels are forty-two inches in diameter. There will be four motors of 200 horsepower each connected to the axles of the locomotive. Thus the entire weight of the locomotive will be placed upon the truck, thereby becoming available for adhesion. This feature of construction will be readily recognized as a very advantageous one over other locomotives, where only a small percentage of the weight is available for adhesion.

The locomotive completely equipped will weigh 160,000 pounds. The motors will be geared, which method has been decided upon so as to enable the company to use more efficient and durable motors and also greatly reduce the cost of the locomotive. It is stated that while the electric locomotive used in the Baltimore tunnel cost $50,000, the Baldwin-Westinghouse locomotive will cost less than one-third of that amount, and yet it will be able to accomplish the same work. The Baldwin-Westinghouse combination is constructing engines for all kinds of purposes. The one described here is the regular passenger engine, rated at 1,000 horsepower capacity. Then there will be locomotives made to be used in mines. The latter will have six driving wheels and the superstructure will consist of a sheet iron cab. The switching locomotive will also have a cab as a superstructure. There will also be manufactured locomotives for tunnel work, suburban traffic and rack locomotives, as well as for elevated railroads.

It is expected that within a few days the second locomotive, as completed by the Baldwin people, will be received at the East Pittsburg factory of the Westinghouse Electric and Manufacturing Company. This last one will be of the elevated railroad type and is an example of a motor car of the Manhattan Elevated Railroad of New York.

As far as the speed of these new locomotives is concerned, it may be stated that the motors have been geared to produce a speed of seventy-five miles an hour, although it may reach 125 miles an hour, if it were demanded. All Westinghouse-Baldwin locomotives will be equipped with air brakes, which will be operated in the usual manner by air pump underneath the car and which will be driven by an electric motor.

The Westinghouse-Baldwin locomotives have been designed so as to be utilized with any method of electric traction. They can be used with the trolley system, the third rail system, the Westinghouse electro-magnetic system, and they can also be utilized in connection with the Tesla polyphase system.

Since it has become known that the Baldwin-Westinghouse companies are constructing electric locomotives inquiries have come from all over the world for such machines, indicating the wonderful demand there is for such engines when they are manufactured by such well-known firms as the Baldwin Locomtive Works and the Westinghouse Electric and Manufacturing Company.

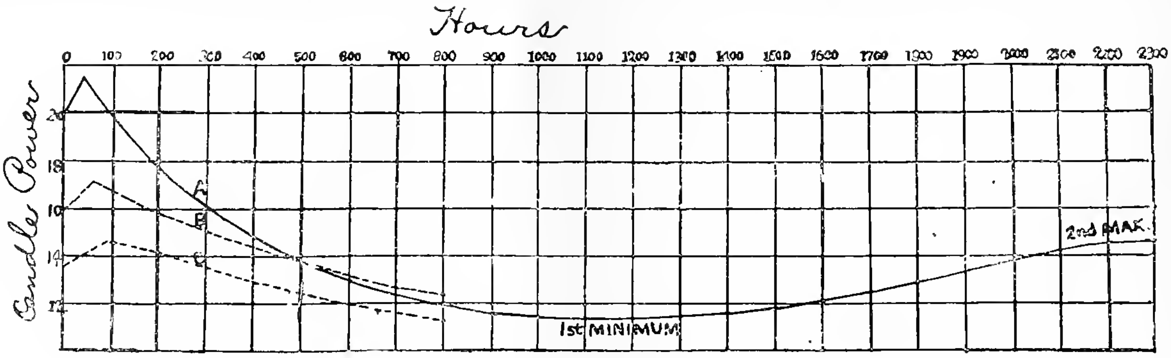
W. H. Preece, Electrician-in-Chief of the General Post Office of London, Eng., states that since the introduction of electric light at the General Post Office, the number of days of absence because of illness among the officials has ben reduced to two per annum for each individual, effecting a saving of no less than 3,000 days of work per year.

INCANDESCENT LAMP EFFICIENCY.

BY LIEUT. W. STUART-SMITH, U. S. N.

In a paper read before the American Institue of Electrical Engineers in 1893 Mr. Carl Hering said: "It is descent lamps to have a long life; the object of this paper is to show that this is a delusion and that it is not substantiated by facts, but on the contrary under normal conditions a very much shorter life represents an actual gain in dollars and cents." At the close of an able paper he says: "The results clearly show that it is absurd to keep lamps running too long and that the life of our present lamps is more than sufficiently good."

Of course Mr. Hering cannot be accused of advocating the idea that long life under any circumstances is bad, but his meaning is that while lamps are subject to their present infirmities such as rapid falling off in efficiency of filament as a light producing medium and rapid falling off in efficiency of the globe as a light transmitting medium (owing to blackening, etc.) it is folly to



Incandescent Lamp Efficiency.

attempt to retain them indefinitely on the active list to the detriment of a service, the efficiency of which would be increased by the more rapid promotion of the younger and more progressive lamps. It is, of course, desirable that the life be increased indefinitely, if the effici-
generally supposed that it is an advantage for incan-
ency can be maintained and to this end much study and experiment has been given.

Considering the globe, there is evidently but one method of maintaining its efficiency, viz., by preventing any deposit which will interfere with free transmission of light. Considering the filament, there are manifestly two methods open, either of which will be effective; First, by preventing any removal of material from filament, by vaporization or otherwise, thus maintaining permanently the original surface; second, by causing the removal of material to be uniform over the entire surface, thereby keeping the character of the surface the same during the life of the filament. Maintaining the efficiency of the globe evidently depends upon the first method of maintaining the efficiency of the filament since if there is no removal of material from the filament there can be no deposit on the globe, also if such removal could be prevented the life would be indefinitely prolonged if there were no other forces operating to cause rupture. In practice the life of the filament would be limited by its ability to withstand the shock to which it is subjected each time a high e. m. f. is suddenly applied, but during the life the efficiency and candle power would remain unvariable.

It is not difficult to say what should be done to maintain the efficiency of the filament when either of the above methods is adopted, but how to do it is less readily explained. In order that filament may wear away

uniformly so as to maintain a surface of similar character throughout the life of the lamp it is requisite that the structure be asolutely homogeneous so that the tendency for vaporization to take place from one part will not be greater than from any other part. Vaporization takes place from the surface of all substances and at all temperatures, and in a confined space every substance is surrounded by an atmosphere of its own vapor. The density of this atmosphere is definite for every temperature and when once the space surrounding the substance is filled with vapor of the substance having the density due to the temperature, no further vaporization can take place unless the vapor density in the space be lowered by a portion depositing on the surrounding walls. In this case a further vaporization will take place and such vaporization and deposition will be continuous as long as there is a surface with which the vapor can come in contact, which is cooler than the surface of the substance undergoing vaporization. In an incandescent lamp having the globe in contact with the air, condensation of vapor must be rapid if it can come in contact with the glass as is usually, perhaps always, the case. It is generally supposed that carbon is a substance which vaporizes with the greatest difficulty and that under any circumstances the vapor density must be very small, but there is reason to believe that with the temperature attained by the filament vaporization takes place very freely and the vapor density in a burning lamp is comparatively great. Whether the removal of material is due to true vaporization, air wash or otherwise is immaterial; the appearance of the globe is sufficient evidence that removal does occur. True vaporization is probably the cause. If the filament is not homogeneous some portions must be more easily vaporized than others and this fact readily permits of an explanation for the falling off of efficiency. The light giving power of a hot substance depends upon the nature of the surface and for a given temperature the intensity of the illumination will vary with the surface. When the filament is heated to incandescence and begins to radiate light, vaporization takes place at rapid rate and if the material of the surface is uniform in its nature this vaporization will take place equally from the entire surface and the character of the surface, and hence the intensity of the illumination will remain constant if the temperature remains the same. If, however, the filaments are not homogenous vaporization will take place more rapidly from one point than from an adjacent point with result that small pits will be formed. At first these pits will not have a depth comparable with the length of light waves and the resulting roughness, by increasing the light-giving surface, might have the effect of increasing the candle power of the lamp in every direction except that normal to the surface of the filament. After a time, however, continued vaporization would cause some of the pits to have such dimensions that light radiated from the bottom would be half a wave length behind light radiated from the top, and destruction by interference would take place with resulting slight diminution of the intensity of the illumination. Experiments show that when lamps are first burned there is an increase in the illumination for some hours, due to a cause which is probably complex. When the loss by interference is equal to the gain from whatever causes are acting, the intensity of illumination will reach a maximum and a tangent to the curve will be horizontal; this continued unequal vaporization will cause a greater and greater number of points of interference to form with a resulting decrease in efficiency. As the process goes on the first pits formed will reach such a depth that the vibrations are no longer a half wave length apart and interference from these will diminish until finally when the depth is such that the vibrations are a full wave length apart the intensity of illumination at these points will be the same as at first. A continued operation of this kind will result in interference from a maximum number of points distributed over the surface and the efficiency will reach a minimum value, after which it will rise again to a second maximum, lower than the first since there will always be some points of interference.

Theoretically there should be a series of such maxima and minima, but the life of the filament is not sufficient to exhibit them. The accompanying curve illustrates this, it being taken from a former article by the writer, published in the Electrical World March 3, 1894. Manifestly if the filaments were absolutely homogeneous, though they would waste away and the candle power diminish, yet the surface would retain the same character and the efficiency would remain constant during the entire life. Of course the carbon uniformly removed would deposit on the globe and the efficiency of the lamp would fall. The production of uniform filaments, therefore, while beneficial, would not hold up the lamp efficiency unless at the same time vaporization was prevented.

It is impossible entirely to prevent vaporization from the filament because the ultimate vapor density of a substance in a confined space will always be the same, no matter what other vapors may be present, but in the presence of other vapors a longer period is required for the density due to the temperature to be attained, owing to the opposition offered by the other vapors to the free penetration of the new vapor into every portion of the space and proper advantage being taken of this fact may make it possible to prevent vaporization to a large degree. Manifestly condensation on the globe cannot be as rapid if other gases in the globe prevent a free passage of the carbon vapor from the filament into all parts of the space within the globe and to this extent any heavy vapor ought to be to some extent beneficial.

It is well known that some vapors tend to condense on the surface of glass, the vapor of water being a notable example, and it seems to the writer that some effect of this sort may e the true explanation of the action of bromine. If this vapor tended to condense on the glass so as to form a layer of considerable density the carbon vapor would impinge against it and be unable to penetrate it so as to reach the glass and be deposited. The layer of heavy vapor would be interposed as a comparatively impenetrable wall, which would keep back the carbon vapor. Deposition being thus largely prevented, when once the density of the carbon vapor reached the limit due to the temperature no further vaporization could take place except to make good the small amount which succeeded in getting through the gaseous wall. When the lamp was extinguished the vapor present would settle on to such places as were available and the next time the lamp was lighted there would be further vapor given off sufficient to fill the globe. This continuing, there would be some falling away in efficiency, but it would be slight compared with a lamp filled with a sustance which did not tend to condense on the glass.

If this view is correct the way to prevent vaporization and thus maintain both the filament and globe at a high state of efficiency is to make a careful study of various gases with reference to their behavior in presence of glass and introduce into the lamp such vapor as is found to form a layer of considerable density on the glass.

Berkeley, Cal., Feb. 28, 1896.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

POLICY IN RAILWAY MANAGEMENT

The action of the Oakland, San Leandro & Haywards Electric Railway Company in conceding important points to the people of San Leandro without regard to their legal rights is an act of policy which should commend itself to the managers of all quasi-public works and especially those who have in their hands the formation of policy for electric railway enterprises. Every electric railroad depends for its earnings upon the good will of those resident near its line, even to a greater extent than is frequently acknowledged by those having charge of operating such tram lines. In some cases people are compelled to make use of cars whether they are favorably disposed towards the management of the road or not but in every case much traffic will be lost through ill will towards the management and an electric road needs to concede more to its patrons than is necessary in any other form of business. There have been throughout the country far too many bitter contests between railroad managers and the patrons of the roads, resulting in competing lines, expensive legal fights and in continuous loss of revenue; besides a running fight over the placing of poles, laying of tracks and the suspension of trolley wires, all of which elements effect the treasury of the road and all of which are the result in many cases of a needlessly independent attitude taken by the railroad management. The effect of the opposite policy is shown very clearly in a paper read before the National Street Railway Association by the superintendent of the Reading, Penn., Street Railway Company in which the author described the process by which this road which had for a long time remained an unprofitable property was thansformed into a paying investment, and solely by the means of so far earning the good-will of the inhabitants that the habit of riding on all occasions was acquired by the residents of the town.

It is not sufficient for an electric railroad to provide parks and concerts to which they may run excursion trains, for such entertainments must be continually varied and are a continual source of expense to the management, whereas the conciliation of those who are the natural patrons of the line obtains the most profitable and least expensive traffic, making the most profit-one of the local institutions and supported strongly by local pride, which forms not one of the least important of the assets of the company.

ELECTRICITY IS NOT A CURE-ALL

Electrical engineers have applied their brains to the solution of so many problems in many fields and have been so successful in the main that they are often tempted to consider themselves capable of teaching the men of all other trades. A notable exception to this success is to be found in the recent "off-hand" attempts of some well-known electricians to suggest inventions of military devices. Within a few days of each other we have seen Mr. Edison and Mr. Martin describing their ideas of the application of electricity to warfare in articles which show only too plainly that these men have gone outside their province in attemtping to apply electricity to the art of destruction. It is hardly, at the present time, necessary to point out the absurdities in the plan of Edison since the attention it has received on both sides of the water has compelled all of our great inventor's friends to disclaim the idea of seriousness in his original communication.

The other proposition for defending the sea coast by the means of trolley road forts has not received the same notice but has about the same value and fails for much the same reasons that Mr. Edison's proposals were criticised. The idea of defending a long line of coast by the means of forts loaded on trolley cars apparently is based on the idea that warfare is only carried on against forts and neglects altogether the fact that while the moving fort might be engaged on one part of its line with a portion of a fleet another squadron could easily destroy the means of communication between the fort and its central station unless the coast was transformed into a continuous line of fortifications which would render the trolley road a useless addition to the expense.

We have here only another example of the wasteful folly that has led many electricians into advocating the solution of all problems by the application of electrical energy without their stopping to consider that they have responsibilities as engineers which should lead them to guard against unwarranted applications of electricity as well as to urge its use where such use may prove to be a financial economy. The outcry has been raised against the education of so many electricians, but so long as the electricians now practicing are incapable of understanding this fact that they should be first, wise men and wise engineers, and secondly, intelligent appliers of electric power, we will demand not a smaller number of electrical engineers but, on the contrary, a larger number of efficiently educated engineers.

THE MISSION OF JOURNALISM

One is often compelled to wonder whether the American technical or trade journal has a mission in existence beyond securing advertising patronage and the distribution of advertisements and even to wonder whether the mission of the simple distribution of advertisements is satisfactorily carried out by the editorial methods employed in furnishing reading matter. If such papers have a reason for their existence beyond that furnished by their utility in the cheaper distribution of advertising matter it seems certain that they should be thought of as furnishing a guide to engineers and purchasers as well as to investors in apparatus and engineering un-

dertakings which will reduce to a minimum the waste of time and money in foolish and impractical schemes. If their province, on the other hand, is simply that of the distribution of advertising matter their reading matter should be of such a character as to make the papers valuable to those who may purchase and for whose eyes the advertisements are intended; but when we look around us we are compelled to the conclusion that only a very few of the technical journals are attending to either of these needs. In another column we notice the publication of an article describing an invention which embodies a most egregious mechanical fallacy. The editors of the journal publishing this are known to have been thoroughly enough trained for them to have disclosed the impossibilities of the conclusions in the article they have printed, and yet they give no hint of its fallacies. Many of the articles we see from day to day are little more than abstractions from patent specifications of untried and probably inoperative apparatus, while the most earnest comment ever made is that " no doubt engineers will watch for further development,' never considering for an instant that it is to the editors of these journals that engineers should look for an honest criticism which may render unnecessary expensive and useless experimentation. The journals are daily multiplying in number to such an extent that advertisers are already beginning to look with suspicion upon their usefulness as mediums for distributing information, though such usefulness will not be once questioned where the advertiser is assured that the journal is read by electrical engineers and artizans for the information it contains and not simply by novices out of curiosity.

From every ground then, whether of selfishness or of morality we should appeal to the editors of all of our electrical journals for some opinions and more carefully obtained information and for less matter which bears so clearly the stamp both of the business office and of the untried mind.

THE IMPORT OF RONTGEN'S DISCOVERY

One of the most remarkable facts connected with the recent discovery of Professor Rontgen of the transparency of various mediums to a new form of electro-magnetic or light vibrations is the wide spread interest and the immedate appreciation of the value of the discovery. We have been accustomed to state that a scientific discovery was compelled to lie many years unapplied before its importance was appreciated by practical men, but at the present time we see a discovery in an entirely new field of scientific research brought to immediate practical usefulness. This is due not only to the character of this discovery and the ease with which it is applied, but not less to the fact that modern training includes so much scientific knowledge in the education of every man that the old distinction between the theorist and the practitioner has become gradually lost sight of and the best practitioner of the present day is considered to be the man who can make his practice conform most closely with recent advances in theory.

At the same time we are compelled to acknowledge that much of the information we have obtained of this discovery has filtered down to us through the unreliable source of the daily newspaper, and the sound advances that have been made have to be eliminated in every account we read from the additions of a vivid newspaper imagination. In every account we pick up we find descriptions of photography by the means of cathode rays, though Prof. Rontgen, in his original paper, considers his own discovery to be of a ray which is altogether dissimilar from the cathode ray, the properties and effects of which have been known since the time of Crookes and photography, by means of which was performed by Lenard over a year ago with results altogether dissimilar to the remarkable results of Rontgen.

It may be well here to enquire what is a cathode ray and how does it differ from the rays made use of in this most recent photographic method?

If while a tube of glass containing two metallic electrodes is being exhausted, a continuous electric discharge from a rapidly alternating high potential source of current be maintained between the terminals, we find that at first the tube begins to glow with a pale blue phosphorescent line marked off in distinct striations, the path of the light flowing from one electrode to the other through the tube in the shortest possible path. As exhaustion is made more complete the striae disappear and the seam of light proceeding from the positive electrode shoots forward in a straight line, while the space around the negative pole becomes completely black, though this space is not free from molecular action, as may be made apparent by placing in the path of the dark rays any material capable of flourescence, the effect being that the flourescent material will at once glow brightly. These dark rays are the cathode rays. Crookes and subsequent discoverers have proved that these rays may be easily deflected by a magnet, in that a thin sheet of aluminum or other metal will stop them almost completely, in that they are sufficiently energetic to heat a body placed in their path, or to turn a small wheel upon whose vanes they impinge. Not only are they incapable of passing through thick metals or other screens, but also they are completely eliminated by the presence of even a small amount of air, hydrogen or other gas. If now, while these cathode rays are being sent off from the negative electrode in the exhausted tube, they be allowed to impinge upon the glass containing walls, it will be found to glow in a bright flourescent spot, from which in the outside air the so-called "X" rays of Rontgen take their origin, being formed at the surface of the glass and transmitted not only through the air, but through all bodies in the inverse proportion to their densities. Unlike the cathode rays, they are not influenced by a magnet and not stopped by screens, and are not deflected by refraction, hence Professor Rontgen concludes, that he has discovered a vibration in the ether which is longitudinal and not transverse, as are the vibrations of light, as proved by Fresnel or electro-magnetic vibrations, as proved by Hertz. Should this conclusion of Professor Rontgen be borne out by subsequent experimentation, a most important addition to the electro-magnetic theory of light will be made and many of our ideas concerning specific inductive capacity and refractive indices must be altogether rearranged. To scientists this is even of more importance than the effects which have been already described in the photographic applications of these rays.

It may be proper to point out in conclusion that there is no doubt but that most of the illustrations heretofore published in the daily papers have been clearly manufactured in the newspaper offices with the exception of the photographed razor by A. C. Swinton, and the photographic sheet of Professor Wright of Yale. No clear photographs of skeletons or skeleton hands have ever been made; what has been done consists in showing outlines of the bones of the hand and feet as slightly darker than the outline of the flesh, though neither bones nor flesh appear as photographed in relief, but only as silhouettes in shadow.

Passing Comment

AN EDITORIAL REVIEW OF CURRENT EVENTS AND THE PUBLICATIONS OF CONTEMPORARIES.

THE INFLUENCE OF TROLLIES ON TELEPHONES.

Some very surprising conclusions are reached in an article by C. S. Du Riche Preller in the London "Electrician" of January 10th on the telephone disturbances produced by electric tramways, in which he states, from experiments performed on no less than six Swiss tramways operating under reasonably similar conditions so far as telephone lines are concerned, that the greatest disturbances of telephonic communication takes place where the American trolley wheel is used and the least where the sliding shoe contact or the Simens-Halske contact arm is employed. These conclusions are explained by the author as being due to the fact that in the ordinary wheel trolley construction numerous contacts are required for keeping the trolley line in the center of the track, and these contacts are so made that jumping of the wheel takes place with consequent flashings and surgings of the current made evident by inductive disturbances. With the contact arm and the sliding shoe, on the other hand, the supports are not so numerous and are so soldered that a perfectly smooth surface is offered by the wire for the passage of the contact which does not jump and scrape entailing consequent surgings of the current. These conclusions are surely worthy of careful consideration and careful experimentation though the experience we have already gained does not seem to bear out the conclusions entirely. Listening to a telephone in which there is inductive disturbance from a long suburban line running few cars, one can readily distinguish between flashings at switches or trolley supports and the continuous singing of the motor while the trolley is running along the smooth wires. This would indicate that either there is a continuous jumping of the trolley wheel or that the disturbance is due to the variations in the current altogether independent of the trolley contact. From certain references to noises made by the cars and the trolley wheels in these experiments of Preller one would come to the conclusion that the author had been experimenting with better motor machinery where the sliding shoe was used than where the contact wheel was employed, which may possibly account for a portion of the difference in the disturbance noted. If, now, experiments should bear out these conclusions which we have here noted a very important step will have been taken in the question of the ownership of the underrunning trolley patent since it will be proved to be not the only system of contact but even to be not the best system for general use.

TRADE CATALOGUES AS BOOKS OF REFERENCE.

The question of trade catalogue manufacture and preservation is well discussed in articles printed in the "India Rubber World" of January 10th and in the February number of the "Engineering Magazine," and it is hoped that by a continuous agitation of this subject some of the confusion now obtaining in this matter may be reduced. At the present time those who are issuing trade catalogues seem to make them as eccentric as possible with the idea that they will serve something of the purpose of a bill board poster, and for the first hasty glance this may be the purpose served by eccentricities of form. Beyond this first glance the trade catalogue should have an importance as a book of reference and be as easily handled and preserved as any other book of refence in a man's library. When this is true the catalogue is likely to be preserved and kept constantly before the intending purchaser, but when the catalogue of eccentric form is received and will not stand properly on any bookshelf or lie easily in any ordinary filing case, the catalogue is apt either to be consigned to the waste basket or to a pile of neglected papers, journals and other such publications. The writer in the "Engineering Magazine" describes a method of preserving catalogues in ordinary letter filing cases about 10x12 inches square which may be indexed and otherwise handled as a letter file or pamphlet box, but when we consider how many of the really valuable catalogues we are daily receiving that cannot be preserved in this manner we see how great a mistake is being made by those who issue these books. Trade catalogues are items of great importance and expense to manufacturers and are capable of yielding a desirable form of advertisement not only by including in the text information which is too valuable to destroy but by presenting the catalogues themselves in such form as to make them easily preserved and to render them essentially parts of a business man's library.

So long as the printers control this business just so long will the eccentricities of form be continued, but when the manufacturers begin to consider the needs of the users of their catalogues they will at once see the need for making the catalogue easily preserved and readily available for reference.

THE BISULPHIDE OF CARBON FALLACY.

So long as men will devote their time and money to the solution of the problem of perpetual motion it is perhaps not surprising to find that less apparent mechanical fallacies deceive those who are fairly well educated and reasonably conversant with mechanical principles, but one does not look for such denseness amongst the editors of our best electrical journals, and yet the "Electrical Engineer," in its issue of January 1st, devotes more than a page to an elaborate description of a carbon biculphide engine which repeats again persistent mechanical fallacies. It is true that this curious fallacy has never been more alluringly presented or with a greater show of apparent efficiency since the bisulphide of carbon is itself heated in a steam bath, the pressure of which will not run the engine driven by the bisuphide of carbon vapor, and under the conditions described in the article there is no doubt but that a greater efficiency is obtained from the use of the bisulphide of carbon vapor than from the use of steam direct from the boiler described. This plan depends for its illusiveness upon the fact that the pressure of the bisulphide of carbon is greater than the pressure of water vapor for a given temperature and in consequence the temperature of the exhaust from the bisulphide of carbon engine may be considerably lower than the temperature of the exhaust of a steam engine; consequently at low initial temperatures the possible working range is greater with the volatile bisulphide of carbon than is possible with steam, but when we attempt to increase the upper temperature limit as in modern steam engine practice the pressure of the bisulphide vapor becomes uncontrollable and in consequence the efficiency of the vapor cannot be insreased to so high a limit as is possible with water vapor by increasing the initial temperature of the steam. Since bisulphide of carbon is a gas at a temperature slightly above the ordinary temperature of the air the range of temperature can be greater in its use than is possible with steam at the same initial tem-

perature and by lowering the value of T_2 in the efficiency formula $\frac{T_1-T_2}{T_1}$ we increase the efficiency of the working fluid, but as we have pointed out it is impossible to use this gas at the maximum values of T, which are obtainable with steam and in consequence the efficiency of the bisulphide of carbon engine must be necessarily small as compared with steam engines as they are used in practice, though it may be greater than the efficiency of a steam engine using water vapor at 25 pounds pressure as describel in this article.

Furthermore, direct heat cannot be applied safely to a bisulphide of carbon boiler and in consequence loss of heat conduction takes place which is far greater than under the ordinary circumstances of a steam generating plant. As we have stated, the fallacy is very ingeniously concealed in the description of this apparatus, but no one who understands the principles of the working of steam or the efficiency of the steam engine can fail to detect the very apparent fallacy in the plan and the inevitable loss of energy in this means of heat transformation.

Literature.

DYNAMO ELECTRIC MACHINERY. By Silvanus P. Thompson, D. Sc.; fifth edition, revised; pp. 835; 19 plates. New York: Spon & Chamberlain. Price, $5.50.

Since the publication of Professor Thompson's Dynamo Electric Machinery this book has been considered by students and electricians in general to be the standard authority upon dynamo machine design and the various editions have from time to time indicated the progress of the art and theory of dynamo electric machinery. The arrangement and origin of the book, however demands inquiry concerning its comparative availability as a text book and as an engineer's manual. As a text book the vast amount of matter included requires a very extended course for its complete reading and the manner of statement of the various propositions throughout the book requires often a very thorough understanding so that the student should devote a considerable time to collateral reading in order to obtain a complete knowledge of its many theoretical propositions, at the same time the manner in which the subject has been presented by the author leading to the complete theory of each part of the dynamo machine by successive easy steps makes the treatise one most easily read by elementary students and, where the necessary time is availale for so complete a study of the subject, the teacher can hardly choose a better work as a text book.

Considering the book as a manual for engineers we find expressed in it the complete and accepted theory of the design of the dynamo electric machinery given in a manner which is at the same time concise, clear and devoid of intricate theoretical considerations. The main types of construction are elaborated in detail whether of a mechanical or electrical nature, or whether concerning the details of armature of commutator or field magnets. At the same time the arrangement of the book in progressive chapters which we have spoken of as an advantage from the student's standpoint, makes the work an exceedingly difficult book when used solely for reference. The effect of this arrangement may be at once seen by a glance through the table of contents in which from six to ten references extending through the entire book are given for every important detail of construction. This, however, is indeed not a great objection when one is completely familiar with the contents of the book and of its arrangement but which, as stated, renders it unfit for use solely as a manual for reference. In some of the earlier editions, particularly the third, methods of construction and of regulation in dynamo electric machinery where described and advocated which were unsuitable for practical use and in some cases were impossible to realize, but in striking contrast we find all of such matter has been carefully removed from this fifth edition and throughout the entire work the student always remains upon sure ground and learns the theory and method of construction which have been proved to be applicable in practical cases a change that has vastly enhanced the value of the work while reducing its bulkiness by extracting matter of doubtful utility. It is with regret, however, that we notice the contraction of the chapters devoted to magnetic principles and the magnetic circuit since this contraction has reduced the formula for calculation of field magnets to too nearly the class of "Rules of thumb" unless the student is either capable of supplementing the work on his own account and follows an extended course including not only the elements of electricity and magnetism but also the author's work upon the electromagnet. The reductions in these chapters and similar reductions in corresponding parts of the book constitute the most important differences between the fifth and fourth editions until we reach the portion devoted to alternate current machinery which has been much extended and rendered more clear by use of the theory of alternate currents as developed mainly by Kapp, Bedell and Crehore and Steinmetz. This section, which is devoted to the exposition of the alternate current transformer, the synchronous motor and the asynchronous motor, while being little more than a sketch of the subject, is sufficiently clear to be understood by those students whose mathematical and physical courses have included only elementary studies which is noted with a great deal of satisfaction not only on account of the fact that a book has been written which presents the elements of alternate current working so clearly that they can be understood by elementary students but also for the reason that it is gratifying to find the theory of alternate currents so far developed as to be clear in the minds of those who have made an extended study of the subject. This is a state of knowledge which has only been reached within the last two or three years.

It is noticed with regret that the author has adhered in this new edition as well as in the recent edition of the "Lessons in Electricity and Magnetism," to the notation adopted in a haphazard manner before that of Hospitalier received general sanction and surely the chances demanded by this new notation are at once so slight and so important as to be concurred in without dispute by writers in general. It is therefore regretable that Professor Thompson has not lent the weight of his authority to the new system especially at this time when he is rewriting all of his important books and could have most readily made the change.

On the whole, this fifth edition of Dynamo Electric Machinery, when compared to the four previous editions shows that the art of the design of such machinery has finally attained a fixed condition and that the theory of dynamo electric machinery design may be presented clearly and in a manner available both to the student and to the engineer.

M. L. B. Pemberton, well known from his long association with the Los Angeles Consolidated Street Railway Company as chief electrician, has opened an office in Los Angeles as consulting and supervising electrical engineer.

Telephony

EXPERIENCES IN LINE TRANSPOSITION.

The art of transposing telphone circuits paralleling high potential transmission lines in order to avoid induction from the latter is now so well understood by electrical engineers that the problem of securing a "quiet" line is no longer one carrying hesitation if not dismay at its suggestion, yet with all the progress that has been made along this line there yet arises almost daily a demand for information regarding the means employed for overcoming what at one time seemed to constitute an almost insuperable barrier to the operation of telephone lines over distances susceptible to induction from high pressure transmission circuits, arc lighting circuits and even from railway systems. Alternating systems exercise such marked influences over all telephone lines in their immediate vicinity after their introduction the necessity for at once abandoning grounded telephone circuits became manifest, but when this had been done the evil became lessened but slightly, and to overcome which the method of transposition now practiced so generally was devised. It is with a view of describing the means for achieving quiet telephonic communication under these adverse conditions that the experiences derived in and about Portland, Or., are here related. This locality is selected above all others on the Coast for the reason that the conditions there existing are not only the first calling for the exercise of originality in devising means for obviating induction, but also because of the fact that there are found all the various systems with which the telephone engineer has to deal. Readers of "The Journal of Electricity" will recall a description of the transmission plant of the Portland General Electric Company appearing in the issue of December last, and in which was pointed out that the company named obtains power from the Falls of the Willamette river at Oregon City, about fourteen miles distant, where are located two stations, station A being on the east bank of the river and containing about 12,000 lamps capacity of Westinghouse, 4,000-volt incandescent high frequency machines operated at 16,000 alternations per minute and 1,100 lamp capacity of Excelsior arc lighting dynamos, at 5,000 volts, besides a miscellaneous assortment of other machines, while station B, on the west side of the river, contains three-phase General Electric generators delivering current to line at 6,000 volts. Almost the entire output of station A is carried across the river, over the suspension bridge about half a mile below the falls, whence it continues to Portland along the west bank of the river, but several arc and incandescent circuits are carried on down the east side to the sub-station in East Portland for local delivery. In addition, the line of the East Side Railway Company runs from Portland to Oregon City, almost paralleling the transmission circuits referred to.

The original telephone line existing when station A was put in operation was of No. 12 iron wire, located on the pole line of the local telephone company, probably one-quarter of a mile from the transmission line. This circuit was used as a grounded line and owing to the number of telephone stations it included was of high resistance, and as would now be known, it proved to be so noisy as to be entirely useless at night, although it rendered good service by day when the incandescent service was not in operation.

The Willamette Falls Electric Company, which then owned the plant, next erected a new metallic circuit on the electric light poles, which was put up without transposition and, like its predecessor, it proved to be worthless except for signalling by bell. Various means were adopted to render this circuit serviceable and experiments in this direction even went so far as to fit each cross arm, carrying a transmission circuit with grounded small copper wires so that any leakage might at once be taken to earth, but the trouble was found to be more deeply rooted than mere leakage effects. Finally, however, the telephone circuit was transposed originally at every half mile, which showed an improvement. The number of transpositions were then increased from time to time until at last the circuit was brought to that condition when it was useful so long as direct currents were on the transmission line, but alternating currents still proved troublesome. Shortly afterward the company installed a Westinghouse arc lighting system, which proved to be the noisiest circuit yet encountered and which therefore rendered telephoning impossible.

As stated in the article referred to the company is now using a six-pair lead cable, which is suspendedin the center of the pole line. The conductors are in twisted pairs and except for miner mechanical troubles the service has given perfect satisfaction and the line, though humming slightly, permits conversation to be carried on with ease. This cable is over thirteen miles in length, which constitutes one of the longest aerial cables in use. The original metalic circuit telephone line is now used for signalling purposes exclusively.

The first experience of the Oregon Telephone and Telegraph Company in the construction of telephone lines paralleling transmission circuits since the abandoning of grounded telephone circuits was in building a private line to the Palatine Hill reservoir of the Portland Water Company, five miles from Portland on the west side of the river. The line was of No. 13 galvanized iron wire, was supported on single petticoat glass insulators and was transposed every 300 feet, the method used being the simple horizontal transposition. The line proved to be unusually quiet. The next line that was built was transposed every 1,200 feet and was found to be about as noisy as the average city line. Shortly after the River View cemetery line was built paralleling the transmission circuits about a quarter of a mile distant. This line is transposed every 600 feet and while it is three and a quarter miles long it is very quiet.

On the east side of the river the long distance circuit of the Sunset Telephone and Telegraph Company parallels the 4000-volt alternating and 5000-volt arc lines of about two miles and are separated from the latter by only twenty feet. Originally the telephone lines were transposed every 1,500 feet, but they proved to be noisy and the transposition was cut down to 600 feet with satisfactory results. These telephone cricuits are of No. 8 bare copper and continue on for more than 100 miles and no inconvenience is suffered from induction. The poles on the east side railway are 100 feet apart and the private telephone line built by that company along these poles was first transposed at every tenth pole and as the road is over ten miles in length the telephones were very noisy, to remedy which Mr. James Curran of the telephone company advised that the transposition be reduced to every eight or every four poles as might be necessary. This advise was carried out by transposing at every fourth pole, when quiet was obtained. As the telephone lines had originally been transposed at every tenth pole and as it is preferable that the length of transposition should be even, the experience of the east

side company emphasizes the advisability of facilitating increased transposition by transposing at only such poles as are in arithmetical progression, viz: poles numbered 2, 4, 8, 16, etc.

No trouble whatever has been experienced by induction from the three-phase system. A single exception to this occurred in one instance, however, when one side of the three-phase line became grounded, and at once every instrument within reach became so noisy as to preclude any possibility of use—this despite the fact that all instruments are on metalic circuits. The impracticability of endeavoring to offset any leakage that may occur on the transmission lines through the means of balancing coils, etc., has also been demonstrated, and although only the horizontal plan of transposition on the same cross arms from end is used, the results obtained have been eminently satisfactory.

Electro-Therapeuty

THE SCIENTIFIC APPLICATION OF ELECTRICITY IN MEDICINE.

BY W. N. SHERMAN, M. D.

While electricity has long been used as a remedial agent, yet its marvelous power attracted the attention of many charlatans and imposters, who made use of it to impose upon the credulous; therefore scientists, loth to be classed with humbugs, refrained from giving serious attention to its development. The recent great advances of this subtle force as a therapeutic measure has kept pace with electrical development in other lines. Instruments have been perfected and are now used by practical physicians in their daily work and there is now a more uniform standard of measurement which enables workers to compare results. We have at our command a number of currents from which to select, and it requires judgment and skill to be able always to select the most suitable one for each particular case and to decide whether static insulation, breeze or sparks, the static induced current, the galvanic, the faradic or the smusoidal is the most useful. Electro-therapeutics has suffered through the ignorance and the improper methods and instruments used in its application. Even at the present time some of our electrically inexperienced brethren call us cranks and electricity a "fad," but we realize that the time is rapidly approaching when they must feel their incompetency by not knowing and using this valuable therapeutic agent.

In the consideration of this subject there are two important facts that should be kept in mind in order to clearly comprehend the object and uses of the various electrodes and instruments used. The first is, that the human body, particularly the skin, offers great resistance to the electric current, and, second, that we are dealing with the fractions of an ampere, instead of the ampere. The voltage of a stationary office battery should be from 60 to 100 volts, while that of the portable battery is from 25 to 50 volts.

Formerly, when electro-therapeutics was not so well understood or so scientifically applied the ampere and the volt were ignored, the operator being guided by the number of cells and the sensations of the patient. Even today some who use electricity hold to this old method. At present the tendency is to use the total current strength of the battery, placing resistance in circuit in the form of some of the valuable rheostats or current controllers made for this purpose, which ordinarily do not reduce the voltage but reduce the current. I shall mention the exceptions to this rule further on. The source of the current for medical use is generally the open circuit cells of the sal-ammonia type, forty to sixty of which are connected in series. The portable galvanic battery consists of primary zinc-carbon cells, twelve to twenty-four of which are connected in series, and when not in use remain outside the exciting fluid to prevent waste and polarization. These batteries require constant and intelligent attention to keep them in perfect working order, while those first mentioned require little attention, and need recharging about once a year.

Rheostats for controlling the current are made in various forms, the best of which are the Massey current controller, the Jewell rheostat and the Vetter current controller. The Massey rheostat is composed of a circular piece of marble over which moves a radial arm, having a metal brush contact at its outer end which moves over a thin layer of graphite, which being the resisting substance can, when worn away, be renewed with any ordinary soft lead pencil. This instrument is very serviceable for electro-therapeutic work and a great favorite with many. The current can be controlled to a nicety, and it may be used on a 110-volt dynamo circuit.

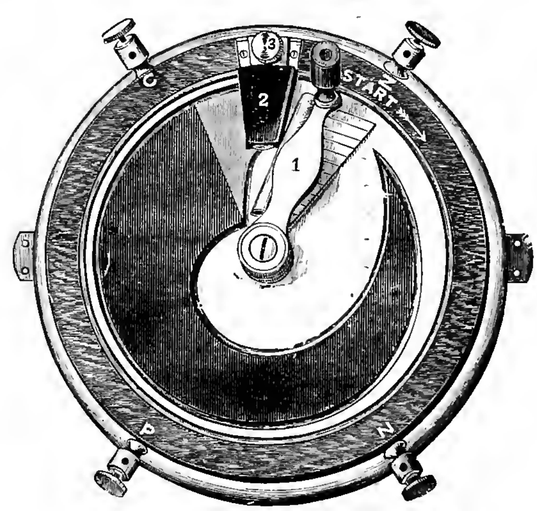


FIGURE 1.—ELECTRICITY IN MEDICINE.
THE MASSEY RHEOSTAT.

The Jewell rheostat is a new instrument made on the same principal and resembling the first-named in form. It consists of a block of slate in which grooves are cut and filled with the resisting substance and so arranged with reference to the moving arm as to make a continuous line equal to the sum of the length of the grooves. It is claimed for it that it possesses all the good qualities of the Massey instrument, having an additional merit of a resisting substance that needs no replenishing.

The Vetter rheostat is constructed on the well-known principle of the variation in resistance which takes place in carbon with a change in pressure. A quantity of granular carbon is placed in a small rubber cylinder, enclosed between two metal plates, to which the two sides of the circuit are connected. The fixed plate is at the bottom of the cylinders and the other is connected to a thumb screw with fine threads, affording a very delicate adjustment. In administering the galvanic current it is a rule always to turn the current on and off very gradually and slowly, thereby avoiding pain and shock. These instruments enable the operator to do this and they possess the great advantage of imposing an equal work on all the cells of the battery. They are

connected in circuit with the terminal wires of the series of cells and save the mass of complicated wires as used with a cell selector. These rheostats are all adapted to use with the portable or stationary batteries.

We shall next consider the method and means used for measuring the dosage or quantity of current used. The instruments used for this purpose are very similar in construction and design to those used for measuring the commercial current, the only material difference being their graduation for thousanths of an ampere instead of an ampere, and for this reason we call them milli-ampere meters or "millimeters." The only portable standard measuring instruments which have been found successful in practice are those of the D'Arsonoal type, in which the actuating force of the index is the current flowing in a coil of wire which moves in a field of one or more permanent magnets, usually of the horse shoe type. In this class of instruments it is asserted that the accuracy may become affected by the weakening of the permanent magnets. A new competitor, the Jewell millimeter, has recently appeared, which claims greater accuracy and less liability to change. The faults above mentioned are avoided by using an improved form of laminated permanent magnets and by so shaping the pole pieces that the magnetic resistance shall be exceedingly small. The instrument has a large travel of index and is so graduated as to afford a horizontal and vertical scale. Milliampere and millivolt meters of the Weston type, so thoroughly familiar to electrical engineers, are also very serviceable and entirely reliable.

Reverting to the Jewell millimeter and referring to the accompanying outline drawing, its action will be understood from the following detailed description: Suppose the current enters at the binding post A. The switch S being opened it passes to N, where it divides, part passing through C, known as the calibrating shunt, to the binding post B, the rest passing through the spiral spring c, the moving coil a, the other spring e, thence to the binding post B.

The resistance of the shunted calibrating coil and instrument coil a then bear such relation to each other that when 10 milliamperes of current pass between the binding posts, the index will be deflected one small division; that is, closing the switch S diminishes the sensitiveness of the instrument ten times, so that a maximum of 1½ amperes may be measured. A pole changer at R renders current measurment in either direction without disconnecting wires from binding posts.

The resistance of the calibrating shunt C and the moving coil a bear such relation to each other that when one milliampere flows from B to A the index will deflect one small scale division. To read above 150 milliamperes the switch S is closed. Part of the current then passes from B through switch S and is shunted to binding post A, the remainder passing via c and coil a to A.

The same instruments described for controlling and measuring the current from stationary and portable batteries may be used on a dynamo current if it does not exceed 110 volts. Among many instruments for controlling dynamo currents for therapeutic work the best are the Gish rheostat, the Vetter current adapter and the McIntosh current controller, the last named being adapted to currents of high voltage. All of these instruments act upon the shunt principle, allowing a main current to pass through a continuous wire, offering a certain resistance and having an additional mechanism for diverting the current at the will of the operator into the patient's circuit.

These devices diminish the voltage as well as the current, an effect of great value in electro-threapeutic work. I have seen the McIntosh instrument working on a 500-volt street car circuit. It gives very uniform and satisfactory results, and is so constructed as to avoid all possibility of danger.

What is said above covers the ground with reference to the source of the current, the instruments for its control and the accurate measurements or "dosage." I have spoken only of the methods and instruments that I consider the best, omitting objectionable methods such as the water rheostat, cell selectors, etc. We shall next consider the means of applying the current to the human body. The means of applying the galvanic current

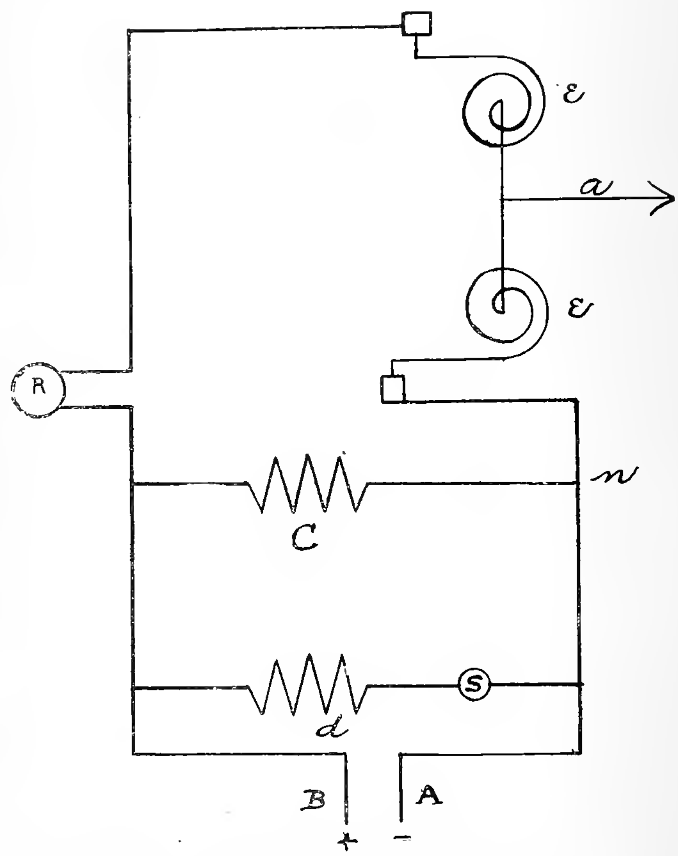


FIGURE 2—ELECTRICITY IN MEDICINE—CIRCUIT OUTLINES OF THE JEWELL MILLIMETER.

to the human body is by electrodes that vary in their construction, size and shape, according to the concentration or diffusion of the current, and the therapeutic effect desired. If applying the current for neuralgia of some special nerve or about the head or face, we use the small hand electrodes, the contact surface being about two inches each way, having small, moist sponges over the neutral or carbon disc. Through these we administer a current of two to ten milliamperes. The stronger current (ten milliameres) would rarely be tolerated without producing great pain or blistering the skin if the active electrode is not moved over the skin or surface. If on the other hand we desire to administer the same current for its deep or penetrating effect, we must choose a large electrode, so as to disperse the current over a large area of the skin surface, in order to lessen the pain. By this method we may administer a dosage of thirty milliameperes without producing pain. A good illustration would be a case if sciatica, commonly called sciatic rheumatism, it being really a neuralgia of the great sciatic nerve. In this case one should apply an electrode (the positive) over the hip or low down on the back, the size of the electrode being not less than 3x5 inches. The foot should be placed on a

larger electrode on the floor, or one of about the same size should be applied to the calf of the leg. After carefully surveying our switches and noting the direction of the current we turn on the current slowly and gradually until we reach the limit of toleration, which will be about thirty milliamperes and this may be continued for ten or fifteen minutes, turning it off in the same manner as it was turned on. The positive electrode is usually placed over the hip in order that the soothing and pain relieving effect of this particular pole may be realized over that sore or tender part of the great nerve, where it issues from the pelvis. With the small electrodes, applied under these conditions the difficulties would be great, beside the limited therapeutic effect would be almost nothing. With the larger electrodes the resistance is decrased, the tension lessened and the arm of the controller will be hardly as far around its cycle as for the ten milliamperes through the small electrodes. For central galvanization, when we desire to reach the great sympathetic nervous system we should use the same electrodes (in size) and place one low on the back of the neck, the other over the stomach or abdomen, or if the spinal cord is to be treated, we place one of the large electrodes at each extremity of the cord.

Now suppose it is desired to concentrate a current to a small area of a mucus surface, inside the human body, for its various therapeutic local or general effects. In this instance we have a great decrease in the resistance between the poles, for the reason that one of them is applied to a moist low resisting surface. We use a small metal electrode, applied to the mucus suface and if we desire a strong current for its electrolytic (or the so-called electro-cautery effect) we shall place a large electrode over the skin surface of some part of the body (preferably the abdomen) which should be at least 8x10 inches in size. The author makes these large electrodes of sheet lead and uses a thick layer of wet absorbent cotton between the lead and skin. In the above instance we should call the larger, the dispersing electrode, and the pointed metal the concentration electrode, the larger also being the indifferent electrode. These small electrodes must be of platinum if we desire to use them as the positive pole. In the apostoli method of treating uterine fibroids by the above method the concentration electrode is a platinum needle and the current strength is often as high as 150 to 200 milliamperes, using a dispersing electrode of moist clay. Such a strong current is rarely if ever used for other purposes in the human body.

I have enumerated and described the ordinary methods of administering the galvanic current and before I proceed to describe other methods I shall touch upon electrolysis, which is the name given to weak galvanic currents applied for the purpose of destroying tissue or altering morbid growths. In the removal of hair, a small delicate needle, the jeweler's brouche, is used. This is carefully introduced into the hair follicle, it being the negative pole, the positive being a sponge electrode held in the patient's hand. Six cells of any good battery is sufficient, the current being from two to three milliamperes. It is not necessary to use a meter, as the blanching of the tissue is sufficient to an experienced operator. If we desire the destruction of a larger growth, such as a tumor, we shall have increased resistance and must use a higher voltage, with about the same current. If a tumor under the skin, we shall use two, three or even four large needles connected to the negative pole. By the same means we destroy all sorts of small tumors, moles, warts, wine marks and other skin blemishes, as well as dissolving strictures and dissolving adhesions, there being special electrodes for these various applications.

The galvanic current is sometimes used for introducing medicines into the body. This process is called cataphoresis, and is an electrical asmosis, used frequently to produce local anaesthesia by means of evolutions of such alkaloids as cocaine and aconitine, also for topical medication in various local lesions, such as tumors, gouty swellings, enlarged glands and various skin diseases. For rheumatism and gouty swellings solutions of the various preparations of lithium are employed. This medicine is driven in, as it were, by means of the current, and acts directly by dissolving any concretions that may exist in the affected part, as a result of the disease. Medicines used in this way are always used in solution and on the positive pole, for reasons that are obvious. The gavanic current alone is frequently used for its dissolving effect upon adhesions around various organs inside the body. The strength of current for cataphoresis is from five to ten milliamperes. By this means chloroform may be used for dissolving gall stones inside the gall bladder.

A similar method of applying medicines or chemicals by means of the galvanic current for their local effect is by means of metal electrodes, such as zinc and copper. This is a local electrolysis, a decomposition by electricity. Both poles are sometimes used close together for destroying malignant tumors. A platinum electrode wrapped with absorbent cotton, moistened with iodine or carbolic acid, is a means of application to mucus surfaces for its local caustic or alterative effect. Some varieties of cancer are effectually destroyed by zinc-amalgam cataphoresis, a blunt amalgamed zinc electrode being passed into the growth, after anaesthesia has been produced by cocaine, and a current of 150 milliamperes passed.

Water electrodes are sometimes used to facilitate the local application of plain or medicated solutions. This electrode consists of a hard rubber nozzle, inside of which is a platinum wire. The connecting end is bifurcated, one connection leading to the water supply or medicated fluid, the other to the battery. As the water passes over the platinum wire it becomes the electrode and closes the circuit by contact with the body. This is a valuable means of treating skin diseases, ulcers and many other superficial ailments.

We use special electrodes for applying the galvanic current to the eye, ear, nose and throat; also for treating the various diseases of the mucus surfaces, and internal organs of the body. These various instruments would require too much time and space for special description I shall next consider the faradic, static and other high tension currents, and the various methods of generating and applying to the human body.

Personal

Mr. A. C. Balch, formerly of the Union Power Company of Portland, was in San Francisco recently.

Mr. Charles Stein, the tie-plate expert of the Q. & C. Company of Chicago, will shortly return to San Francisco with headquarters at the Palace hotel.

Mr. Edward B. Ellicutt, superintendent of constructin for the Western Electric Company of Chicago, is on the Coast on a trip combining business and recreation.

Mr. J. A. Cranston, assistant to Mr. S. Z. Mitchell, manager of the Pacific district of the Northwest General Electric Company has returned to Portland after a brief business visit.

Mr. I. Sternfeld of the City of Mexico and who is Mexican agent of the Westinghouse Electric and Manufacturing Company, was in San Francisco recently closing the orders for several large transmission plants.

Mr. H. T. Llyod, the genial representative of the Stirling Electric Supply Company at Topia, State of Durango, Mexico, is in San Francisco, perfecting arrangements for prosecuting the Mexican business of his company with renewed vigor.

Mr. E. W. Little, whose long and intimate association in the management of the Interior Conduit and Insulation Company has won for him a universal popularity, has resigned the vice presidency and general managership of the company and has been succeded by Mr. Allan C. Bakewell.

Mr. W. S. Heger, manager of the Pacific Coast office of the Westinghouse Electric and Manufacturing Company has returned to San Francisco from Pittsburg with plans for a campaign so fully matured that the measure of their aggressiveness is only execeeded by his personal popularity among those with whom he has business dealings.

Mr. L. H. Griffith, formerly of the Griffith Bank at Seattle, Wash., is at the Grand hotel, San Francisco. At present Mr. Griffith is residing in Guatamala, where he holds important government concessions for building electric street car lines in Guatamala City and Antigua and connecting the two places which are seventy-two miles apart, by electric road.

Mr. John Richards has retired from journalism and with his retirement the publication of Industry has ceased. This announcement has been received with deep regret by the thousands of admirers of his writings, whose gratitude for the frankness, fairness and fullness of Mr. Richards' engineering writings form an ever living and world-wide testimonial of appreciation, to earn which any lifetime is well spent.

John F. Outwater, representing Mr. Hugo Reisinger and the high-grade Nuernberg "Electra" carbons, and who is combining business and recreation in a tour of the Coast, is at present at the Palace Hotel. Since its inception almost, Mr. Outwater has until very recently been purchasing agent of the Brooklyn Edison Company, and the ripe experience there gathered makes him one of the best posted men in the country on the efficiency of electrical supplies.

Professor A. Vander Naillen, the well-known president of the school of engineering in this city, is on the eve of journeying to Paris, France, where he will study the latest progress made in the engineering sciences, and especially in that of electricity. The professor departs loaded down with credentials from the Governor of the State and many different consules here addressed to the various ministers of state in Paris, which will open wide to him the doors of the higher institutions of scientific learning. Mr. Vander Naillen will reap a rich harvest of scientific information which he will bring back to this Coast for the benefit of the public in general and especially for the advancement of his own students, as he is determined that the Vander Naillen school of Engineering shall rank among the best.

ELECTRIC ELEVATOR REGULATION.

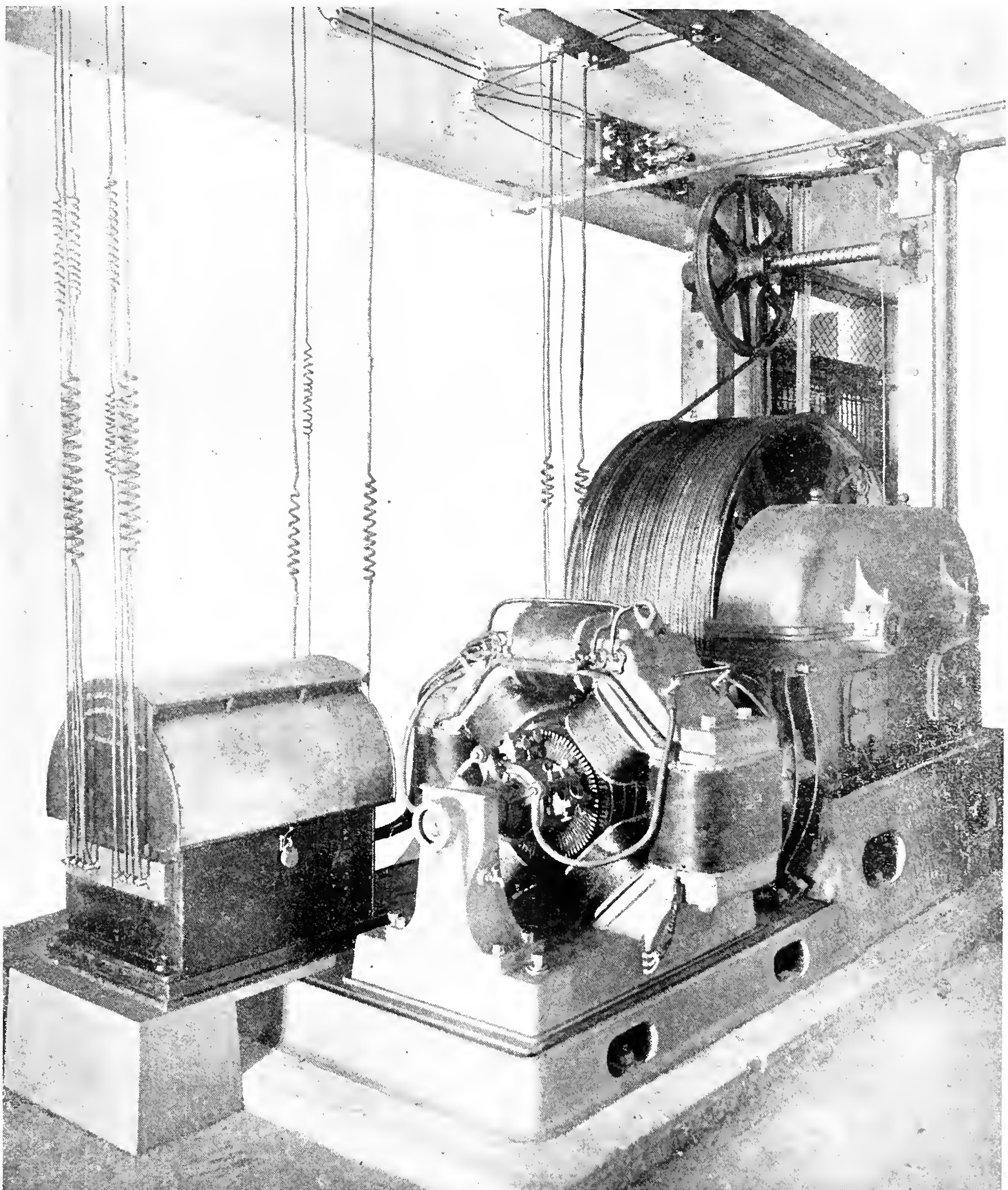
An interesting example of the effiecient application of electric power to the operation of high speed passenger elevators is found in the installation placed by the Electric Engineering Company in the famous Cliff House in this city. The elevator has a direct lift of an even 100 feet and the general character of the equipment is shown in the accompanying illustration from a photograph of the plant as erected. Briefly described, the plant consists of a 25-horsepower Electrical Engineering Company's motor of special type, geared to a sheave drum through worm gearing and operated from the 500-volt circut of the Sutro railroad.

To describe the apparatus in detail is inadvisable at the present time, owing to the fact that patents on its vital features are pending, but an idea of its method of control will be gathered from the statement that the controller proper and which is inclosed in the locked iron casing shown in the illustration, consists of a solenoid, the core of which effects four different combinations of field windings so as to give four distinct rates of speed. This solenoid is actuated by circuits which are manipulated by the operator in the elevator car through an ordinary form of controller lever that forms the various switching combinatios desired. The controlling mechanism is therefore purely electrical and its distinctive feature, which at the same time forms a most valuable characteristic because of the entire elimination of the use of resistance of any form, consists in the commutation of field coils so that the entire energy rushing into the motor upon starting becomes available for torque. It will be noted that the motor itself presents the peculiarity of having windings across the yokes of the pole pieces in addition to the regular field windings. There are, therefore, eight field coils on the machine, and these are of equal ampere-turns and the function of the controller is to commutate these coils.

How this is done will be made clear in a general way from a brief description of the method of operation. The motor is compound wound and when at rest the eight field coils are all in series, and act as a resistance, but the energy expended in them is obviously utilized in magnetizing the fields. The first action of the controller solenoid is of course to fix the armature polarity and then to energize the fields. These functions are performed in the ordinary manner and before the current is thrown on the armature the equipment is coupled as a simple series motor. The fields are highly over-saturated, thus giving a tremedous torque, which at once carries the elevator with an acceleration only equaled by that of the hydraulic form. The various successive stages of the controller commutate the field coils so as to weaken the fields until, when at the final speed, it is run as a simple shunt motor. A bank of 16 lamps in series is placed in parallel with the field coils to take up the discharge and the motor is, as shown, of the two-brush multipolar type. The armature shaft is coupled direct to the worm shaft through a flexible insulated coupling and also carries a twenty-inch brake pulley against which presses two brake shoes, one of which is shown in the illustration. These brake shoes are automatically controlled in starting and stopping by a solenoid carrying a compound winding, the series winding constituting a portion of the main circuit to assist the shunt winding to instantaneous action.

The winding drum has a diameter of sixty inches and carries two sets of five-eghths-inch steel ropes, so con-

nected to the drum that as one set unwinds the other set reels up. and visa versa. The first set consists of four ropes that are attached to the top of the car after passing over a sheave at the top of the elevator well, while simlarly the second set, containing two ropes, is fixed to the top of the counterweght, the only distinction being that the counterweight ropes are guided into the elevator shafe by running under an idler sheave on a spirally grooved shaft. All bearings except those for the drum are of the self-oilig type and the gears are of phosphor-bronze, twenty-eight inches in diameter. The worm shaft carries two hardened steel worms, one right and the other left-handed, thus avoiding all end thrust by exerting a balanced pull, the effort of the second gear being transmitted to the shaft carrying the drum by means of cog gearing which, together with the worm gearing, runs in castor oil.



ELECTRIC ELEVATOR REGULATION.

The car travels four inches to each revolution of the armature, and in addition to all mechanical safeties the equipment is provided with electrical safeties which instantly open the main circuit and lock the entire system in case of trouble.

Owing to the utilization of the energy which in all other types of elevators is wasted through the use of starting resistances, a material economy in current consumption is claimed to be effected and readings taken show that in starting the outfit the initial energy momentarily dashes the needle to approximately 19 to 22 kilowatts, instantly falling to 10 or 11 kilowatts and in less than four seconds dropping to as low as from 5 to 7½ kilowatts according to the position of the controller.

In marked contrast to these readings are those showing the energy consumed by either of the two electric elevators of Eastern manufacture istalled in the Safe Deposit building in which the momentary dash of the needle at the start shows from readings varying from 28 to 40 kilowatts and a minimum consumption of 17 kilowatts. This was after the machines had been running sufficiently long to assure smooth operation as is attested by the fact that at the outset each of the Eastern equipments in the Safe Deposit building consumed over 400 amperes at 110 volts, or about 45 kilowatts in starting.

THE PORTLAND TRASMISSION PLANT.

Since the publication of the article in the December issue of this paper concerning the plant of the Portland General Electric Company considerable progress has been made towards the completion of this interesting installation, particularly in the fact that the rotary transformers are now in operation and are giving excellent satisfaction. With the advent of electric power derived from the falls of the Willamette at Oregon City several steam plants have been closed down, prominent among which is that of the Union Power Company in North Portland. This latter formed an installation that was noteworthy in several respects and which commended considerable attention four years ago, first on account of its being the first railway power plant feeding in to two separate railway systems on a three-wire system of distribution, and second, because of the ingenious manner by which refuse saw dust was conveyed to the plant and automatically fed to a battery of boilers having a capacity of about 1,500 horsepower.

Station A of the Portland General Electric Company is loaded to its utmost capacity and from station B is being operated two three-phase 750 kilowatt machines, the first of which is carrying more than its rated load of incandescent lighting on the four-wire system of distribution heretofore described in these columns and in some instances the load has been so heavy that the company has been compelled to help out the generator with an isolated steam plant in the Marquam and Dekum buildings. The second three-phase machine furnishes power to a rotary transformer from which is operated the half of the Oregon City railroad running between East Portland and Milwaukee, the Barnes Heights and Corneel Mountain road, the Vancouver line, all the city and suburban district lying south of Alder street in East Portland, the new First street line running from Jefferson to Burnside streets in Portland and the commercial power circuit, averaging about 150 amperes. Despite the heavy load carried the service given is better than that obtained from the steam plant formerly used. The third three-phase generator is about ready for use, the delay in putting it in operation having been due to not having the line construction finished between Oregon City and Portland.

As stated, the Portland half of the Oregon City line is operated from the rotary transformer, while the remaining half is fed from one of the 250-killowatt 500-volt exciters in station B at the falls. The entire railway system is now continuous; that is, the circuit is not broken at Milwaukee, the middle point, as heretofere, but instead current is fed to it at 550 volts from Portland and at 600 volts from Oregon City, which gives at the center of the line a much better pressure than could be obtained by feeding independently at each end. The matter of regulation on the Oregon City end of this line has always been a very serious one, because of the fact that no means have been devised for improving upon manual regulation of the water wheels, but under the new arrangement much better results are attained as the feeding point of either end of supply shifts according to the position of the cars and the feeder losses, which tends to act as a regulator for the water wheels in station B. The circuit breakers on the rotary transformer at Portland have been thrown out repeatedly with apparently no effect on the exciters pulling the Oregon City end of the road except an increase in the speed, but this condition does not prevent the circuit breakers being thrown simultaneously.

A 6,000-volt three-phase line has been erected from the substation at Portland to the Portland Flouring Mills, some three miles further down the river, where the potential will be reduced by three special 33-cycle transformers to 350 volts for operating a 75 horsespower induction motor that is to drive the elevator at the flouring mills. This installation is preliminiary to operating the entire mill by electric power, and the work of changing the equipment of the Portland Cable Railway Company from cable to electric with the exception of that portion ascending Portland Heights at a very heavy grade, is in progress. The steam plant at the cable power house is to be abandoned and while the electric division of the road will be operated from one of the rotary transformers the cable machinery will be driven by induction motors after the plan installed in the Portland Flouring Mills.

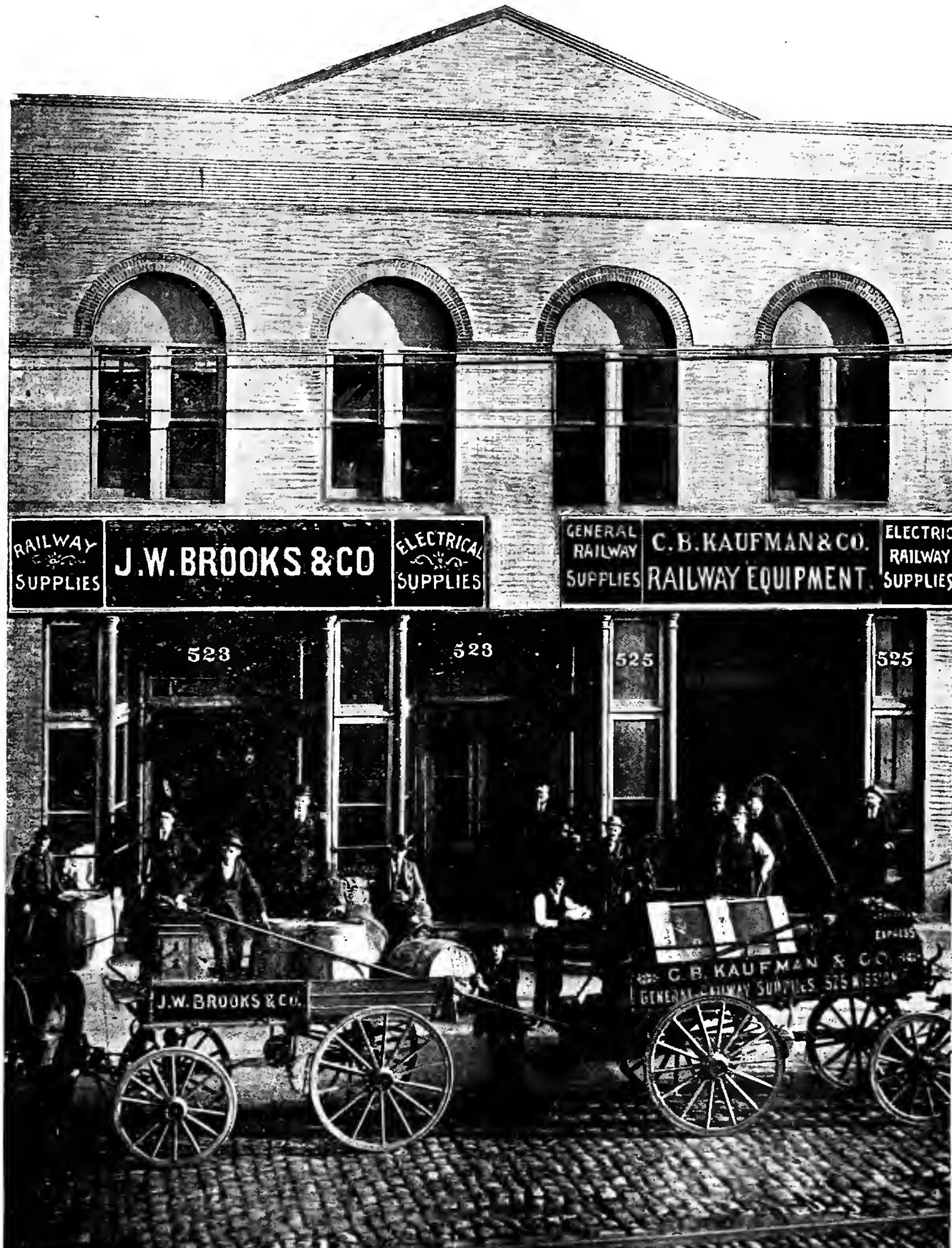
The Trade.

THE NEW FORT WAYNE OFFICES.

As announced recently in the advertising columns, the San Francisco office of the Fort Wayne Electric Corporation has now been established at 18 Second street and the quarters are without doubt the most elegant to be fonnd on the Pacific Coast. Mr. Charles R. Llyod, so well known to the electrical fraternity of the far west, is in charge of the office, which is also occupied by Mr. John R. Cole, whose labors, coupled with the intrinsic merits of the product itself, has made Grimshaw wire the most extensively used insulation on the Pacific Coast. The engineering department of the office is in charge of Mr. Frederick G. Cartwright, and the parties named form a very popular trio whose energies will certainly win a great portion of the desirable business that is to be found on the Coast. The Sterling Electric Supply Company, which is under the immediate direction of Mr. Cole, occupies the quarters with the Fort Wayne corporation conjointly and the office is thus prepared to handle every electrical proposition of whatever nature that may arise.

A RAILWAY SUPPLY CENTER.

It is well known that until the past year one of the great electrical corporations held an undisputed monopoly of the electric railway business of California if not of the Pacific Coast, and that this situation has now been most effectually broken is evident upon looking over the advertising pages of the Journal, from which it will be seen that the business of selling railway supplies is now very thoroughly exploited. The accompanying illustration shows a railway supply center in San Francisco, and although it is but one center of several and although the concerns there located are the youngest in the field, the business transacated in furnishing supplies for electric and steam railways, in addition to the furnishing of electric lighting supplies of every description, has reached a proportion that is most gratifying.



The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

Business with the electrical supply and machinery people is veiry fair, and the outlook for the coming year is better than it was a year ago. Most electrical people are doing a very good business, although some of them say things are dull, but as a rule they are, if not just at present rushed with business, at least full of hope.—Los Angeles (Cal.) Journal.

Owners of land along the line of the California railway, out Laundry Farm way, can well afford to give a bonus to have that line converted from a steam to an electric road. When it is seen how the Haywards line has increased real estate values along the county road it may be judged how it would pay to have this little steam road, running into the most delightful of suburbs, changed into an electric, with frequent trips at low fares.—Alameda (Cal.) Argus.

The destruction of the dynamos of the electric lighting plant at Haywards the other day in the midst of an electric storm warns proprietors of electrical machinery in California that lightning arresters should be put into all their works. Because lightning is very infrequent in this State is no reason for neglecting a precaution, the failure to provide which may result in such great damage and so much inconvenience to a community.—Sacramento (Cal.) Record-Union.

The electrical plants of the Standard Consolidated Mining Company have proved a success and have enabled that company to work its mill and mine more economically than under the old system, and the time will surely come when Bridgeport will be the center of electrical mining plants for the systematic and economical working of the Bodie and other mines in this vicinity. We have an abundance of water power and it is destined for such a purpose.—Bridgeport (Cal.) Chronicle-Union.

The steps now being taken by the City Trustees to increase the electric lighting plant are fraught with gravest consequences to the taxpayers of this city. No one disputes the right of municipality to light its own streets and public buildings, but when it engages to supply private consumers it is going beyond the rightful exercise of the legitimate functions of municipal government; it is entering into an undertaking that at the most is purely experimental. * * * Alameda has had its experience with electric lighting plants and it has been a sad one to the taxpayers.—Alameda (Cal.) Telegram.

Counties are being asked to grant the right to use the public roads for electric railways, and perhaps for the day it might be better to grant the right to run on the roads, but shall we never look to the future in such matters? In how far may the counties undertake the construction of these roads? A corporation uses its credit to build a road, and a county having credit can use it. The corporation gets its pay back by tolls, and why may not the county do so until the debt shall be paid off. If we believe at all in public ownership of transportation lines let us show our belief by taking hold of this new phase while we may do so without any question of wronging any one, or while it may be done without creating so vast a public debt.—Colusa (Cal.) Sun.

All signs of the times at present point to great mining and business activity in this vicinty in the near future. With the advent of that gigantic enterprise, the Bend Electric Power Company, now an assured fact, comes the reliable information that numbers of good mining properties that have lain practically dormant for years are to be opened up and worked on a large scale. We are in possession of authentic information that one mining company, which has in the past been doing development work on its extensive properties only on a small scale, has signified its intention of taking 100 horsepower from the Bend Company as soon as the same can be furnished, and also will erect a 100-stamp mill, and possibly a larger one, with all the attendant buildings and shops. The company has ample capital and is only waiting the introduction of cheap power to proceed with the work on the most extensive scale. And what is true of this company is also the case with numerous other companies and individuals.—Coulterville (Cal.) Miner.

There is a lively interest just now evinced all over the State in utilizing the vast water power of the mountain streams. It is well. The great cost of power to run mills and manufactories is one of the chief reasons why so little local manufacturing has been carried on in California. Coal has been too dear and the best water power hidden away in inaccessible mountain gulches. The new idea of putting dynamos in the hidden places and sending out the power on electric wires over mountains and gulches miles away to railway stations and steamboat and tidewater towns is practical and full of good promise. It will be but a little while till hundreds of places will be supplied with electric power as cheaply as anywhere in the East. When, through the pressure of hard times the labor question, that other stumbling block to successful manufacturing on the Coast, is so far settled as to stamp a badge of honor on every working man, every serious obstacle in Califonria's strides in industrial progress will have been removed. In view of the situation, our own locality has every cause to rejoice over the power that Cache creek can furnish for all time—enough to make the wheels hum in a row of factories thirty miles long. Wake up!—Woodland (Cal.) Mail.

It would appear from explanations made by electricians that under certain conditions even a heavily insulated wire is deadly. This is an important fact for the public to know, as heretofore an insulated wire has generally been regarded as harmless. It sems that an electric light wire should be treated with as much caution as a gun, which timid people regard as dangerous "without lock, stock or barrel."—San Jose (Cal.) News.

It is really time to draw the line on the irresponsible votaries of science. They are carrying things altogether too far. It is bad enough for Professor Roentgen to enable the intrusive snapshot fiend to exhibit to an unfeeling world photographs of the dorsal vertebrae of gentlemen who might be total strangers to him and radically averse to such extreme publicity, but when Mr. Edison undertakes to photograph the interior of the skull and show what, if anything, the victim has inside, and Professor Salvioni enables the human eye to see anything that the Roentgen rays can penetrate, the case demands the interference of the police. Heretofore a person of discretion has been able to congratulate himself on not wearing his heart on his sleeve; but that precaution will be useless when anybody can inspect the workings of the heart in its normal position, and even see what the owner has had for dinner. If everything is to be transparent to the prying eye of science what is the use of clothes, and why not return to the original Edenic condition? Will the front orchestra chairs at the ballet be provided with notices reading: "Drop a dollar in the slot and take out a Salvioni opera glass?" If Edison's malign invention for photographing the interior of the skull prove successful it will work havoc among reputations that have been a precious possession to the community. A noble presence, an air of dignity and conscious power have made a leading citizen of many a man of whom it may be said, in the language of Mr. Bierce, that he "can't write and he can't talk, but they do say that he is a devil to think." Now suppose some ribald scientist should come along with an Edison Paul Pry camera and take a photograph showing a vacuum in that honored citizen's cranium, where the reverent

multitude had confided in the existence of a bulging mass of gray matter. The foundations of society would be shaken. The masses have always been awed by the thought of the mysterious powers that lay behind the impenetrable brows of their great men. How is their reverence to be maintained when the brain of a statesman or divine becomes as visible as the wart on his nose? No; science has clearly overreached itself this time. Most of us want to have a few illusions remaining, and those who prefer to have absolutely nothing left to the imagination can read Zola and Thomas Hardy.—San Francisco Examiner.

Municipal ownership is very much like a man with an income of $100 per month living upon $150. Somebody pays for the excess of expenses over receipts. If it were a clerk in commercial circles his employer would pay for it in a surreptitious manner. In municipal circles it is the taxpayer who submits to the extra burden. Compiled from reports filed with your city officers, I find that, exclusive of interest, the cost of lighting your city for six years and five months has aggregated the sum of $155,223.74, an average of $2,016.27 per month, of $22.90 per lamp per month, and of 19½ cents per lamp per hour. A very liberal estimate of the value of the permanent part of your plant is $30,000, which being deducted, will leave a net expense of $125,223.74, which gives a monthly lighting expense of $1,626.20, or in round numbers an expense of 15 cents per lamp hour. This is without the consideration of interest which has been paid upon the original purchase price. It contrasts very forcibly with the rate charged in Oakland for municipal lighting—of 6.43 cents per lamp hour—the first basis of hourly expense as figured being three times that of Oakland and the second nearly twice. * * * Assuming that all construction work should stop; that your station is in such a condition that no repairs will be required for the next six years; that no towers are to be taken down; no new lamps erected; no poles to be painted; no boilers or steam pipes to be overhauled; no engines to be repaired; no armatures to be rewound; no incandecsent lamps to be renewed; no lamps to be furnished with new parts; no transformers to rewind, and that the expense of maintenance would be only that figured out by your interested employes. Assuming all this, the average cost of the maintenance of your municipal lighting plant would still be, according to the figures which I have submitted to you, more than 75 per cent in excess of the charges made in any other city in the United States for the lighting of the streets.—Abstract of an open letter from John A. Britton to the Board of Trustees of the City of Alameda, Cal.

Reports of the Month.

COMMUNICATION.

FORT JONES, Cal.—Manuel Pereira is to erect a private telephone line between his new electric light station and this place.

SONORA, Cal.—The Sonora Electric Light Company is installing a telephone system throughout this vicinity to afford communication between the different stations and with San Francisco.

SAN FRANCISCO, Cal.—The Sunset Telephone and Telegraph Company has issued orders that certain operators of its country lines must learn telegraphy in order that they may be competent to use the telegraph as an adjunct to long distance telephoning in the transmission of service messages.

INCORPORATION

SALT LAKE CITY, Utah.—The Electric Gold Mining and Milling Company; capital, $3,000,000; all subscribed. Officers: W. L. Nichol, president; H. D. Bastain, vice president; R. W. Nichol, treasurer; S. J. Weigel, secretary.

SPOKANE, Wash.—The Arlington Heights Company; capital stock, $100,000. Incorporators, J. J. Smith of New York, D. S. Walton of East Orange, J. R. Simmons et al. Object, to furnish water, light and heat to the occupants of Arlington Heights and to buy and sell land.

SAN FRANCISCO, Cal.—The Continental Motor and Traction Company; capital stock, $1,000,000, of which $35,000 has been subscribed. Directors: Philip La Montague, W. R. Smedburg, A. J. Bowie, G. I. Ives and W. B. Harper. Gold Mining Exchange. Officers: Walter Turnbull, president; John Daggett, vice president; D. E. Miles, treasurer; J. F. Crossett, secretary. Offices, Mills building.

OAKLAND, Cal.—The Oakland & Livermore Valley Railroad Company; capital stock, $3,000,000. Directors: E. P. Vandercook, George D. Metcalf, A. D. Wilson, H. H. Pitcher and Rod. W. Church. The new company has absorbed the franchise held by E. P. Vandercook for an electric road from East Oakland to Livermore via Dublin and thenew line will have its terminus at the Corral Hollow coal mines.

LITIGATION.

ALAMEDA, Cal.—John T. Fleming has applied to the Superior Court for an injunction restraining the Board of Municipal Trustees from carrying on certain contracts involving the expenditure of a large sum of money to enlarge the municipal electric light plant for the chief purpose of engaging in the business of furnishing incandscent lights to private consumers.

SAN LEANDRO, Cal.—A. C. Hammond Jr. has applied to the Superior Court for a restraining order to prevent the City Trustees of San Leandro selling a $10,000 bond issue intended to purchase an electric light plant. Hammond claims that the election was illegal because the Board of Trustees did not have plans and estimates of the cost of the proposed plant before the election was held.

LOS ANGELES, Cal.—Justice Young, acting upon the verdict of a jury, has rendered the decision that the Los Angeles Athletic Club is not liable for gas which the Los Angeles Lighting Company claims was consumed by the athletic club during five months of 1893 and which did not show up on the meter of the company placed in the club rooms to register the amount of gas consumed.—Thomas F. Tedford has sued the Los Angeles Electric Company for $25,000 damages for injuries alleged to have been sustained while in the employ of the company through its neglect. Plaintiff alleges that he was employed in digging post holes and, acting under orders of a line foreman, he went up an electric light pole and coming in contact with a live wire received a shock which caused him to fall to the ground, fracturing his skull and breaking his leg.

TRANSMISSION.

BODIE, Cal.—The Index is trying hard to induce capitalists to erect an electric power plant for the mines in this vicinity.

OROVILLE, Cal.—The Oroville Gas and Power Company has made arrangements with the Palermo Land and Water Company for more water for running its electric plant.

BERKELEY, Cal.—Power for operating machinery in various colleges of the University of California is now supplied from a 20-kilowatt, 110-volt Edison dynamo in the mechanical engineering department.

ALAMOS, Mexico.—Two 15-horsepower electric motors manufactured by the Electrical Engineering Company of San Francisco are being installed to operate two Richards triple-throw pumps in the Alamos mine.

RIVERSIDE, Cal.—The butts of the poles used on the transmission line for this city and Colton and which line is to be

thirty-nine miles in length together with the fross arms, are being coated with P. &. B. paint.

SACRAMENTO, Cal.—Mayor Hubbard has approved an ordinance granting the Central California Electric Company privileges for supplying electric power transmitted from the foothills of Placer county.—A 25-horsepower, 500-volt Westinghouse motor has been placed in the Capital Box Factory.

STOCKTON, Cal.—H. K. Southwick is believed to be investigating the feasibility of transmitting power from the Salt Spring Valley reservoir to this city. The plan contemplates the development of electric power from the water to be furnished the Plymouth mine, but the reports have not yet assumed tangible shape.

NEVADA CITY, Cal.—The power transmission plant of the Nevada County Electric Power Company, using Stanley apparatus throughout and which was fully described in the November issue of the Journal of Electricity, was put in regular operation on February 6th and is delivering light and power to perfect satisfaction.

SAN FRANCISCO, Cal.—Two 25-horsepower multipolar motors of the Electrical Engineering Company's slow-speed type are being installed in the Bryant street power house to operate blowers.—The Electrical Engineering Company is installing a high-speed passenger elevator in the Saint Anns building and a direct connected freight elevator in the Lilienthal building.

SONORA, Cal.—The Sonora Electric Light Company will be delivering 100 horsepower to the Rawhide mine by means of its new electric plant early in March. The new pole line of the company carries three cross arms for power, lighting and telephone purposes and the lighting circuits in Sonora will branch off at Springfield and terminate at Shaw's Flat with another branch line extending to the marble works.

FRESNO, Cal.—The One Hundred Thousand Club has appointed a committee to perfect plans for an electric carnival to celebrate the completion of the transmission plant of the San Joaquin Electric Company during the coming month. The pole line for the thirty-five miles transmission for the San Joaquin Electric Company has been completed and the crew is erecting poles for the city distribution circuit.

SALT LAKE CITY, Utah.—Satisfactory progress is being made in the direction of the Big Cottonwood power transmission plant. The dam, pipe line, station building, water wheel and dynamo foundations, pole line and transmission circuits are all completed and it is expected that the plant will be in operation by the 1st of April. The company has filed a deed of trust to the Old Colony Trust Company of Boston to secure an issue of $500,000 first mortgage bonds. The instrument conveys the entire electric plant, together with reservoir, pipe line and power station, in addition to several pieces of land. George W. Donellan is president and George M. Cannon is secretary of the Big Cottonwood Company.

SANTA CRUZ, Cal.—Messrs, Swanton & Robinson have given the Westinghouse Electric and Manufacturing Company a contract for the machinery for the first installation of the Big Creek Electric Power Company. The order is for a 150-kilowatt, 1,000-volt, two-phase generator at 7,200 alternations per minute which will supply a bank of self-cooling special Westinghouse transformers that will deliver three-phase current at 11,000 volts to the line. The length of transmission is eighteen and three-quarters miles, and at the substation special step-down transformers will reduce the line current to 2,000 volts, back again to two-phase current for local distribution. Oil transformers having a capacity of 75 kilowatts each will be used as will triple petticoat porcelain insulators of the Fred M. Locke type. The pole line will carry two circuits for power and lighting respectively, which will be carried on seven-foot and five-foot cross arms. In addition the poles will carry a telephone circuit supported on Locke's patent transposition insulator. A Pelton water wheel of 500 horsepower to operate under a head of 1,025 feet is to be installed and the plant is to be completed by May 15th. An order for an additional 150-kilowatt outfit is to be given for six months later and will probably be followed by a third order for 300 kilowatts more. The company has received all deeds to the lands on Big Creek for its operation, and a fifty-year franchise for the erection of poles, lines, etc., has been received from the County Supervisors.

TRANSPORTATION.

STOCKTON, Cal.—The Stockton Electric Railroad Company is contemplatiing the extension of its system into Fairoaks tract.

PASADENA, Cal.—A spur of the Pasadena electric road is to be built to the Crown City Cycle Club grounds on Lincoln avenue.

SANTA BARBARA, Cal.—Work is being prosecuted on the new power house at Summerland for the new electric railway system.

HONOLULU, H. I.—F. S. Dodge, constituting a committee appointed by the last Legislature to investigate the railway systems in the United States reports, that electric railways are feasible and advisable in Honolulu.

SAN BERNARDINO, Cal.—It is stated that the work of equiping the Southern California Railway line with electricity will commence early in April and that the contract for furnishing power has been given the San Bernardino Electric Light Company.

ALAMEDA, Cal.—The Board of City Trustees has awarded a contract to John Martin, representing the Stanley Electric Manufacturing Company of Pittsfield, Mass., for a 200-kilowatt, two-phase Stanley generator, complete with station equipment.

REDLANDS, Cal.—The projected electric railway to Canon Crest Park has not been abandoned as it is believed that the necessary capital will soon be available. The road if built will be operated from the plant of the Redlands Light and Power Company. The franchise expires in November.

CITY OF MEXICO, Mex.—It is currently reported that an electric railway is to be constructed to the Kotol, San Rafael, and adjacent mines for the purpose of shipping their enormous output, and also that the present system of horse car lines in this city will soon be displaced by electric railways.

RIVERSIDE, Cal.—It is understood that within a few days a franchise will be applied for for an electric road to run from the Santa Fe depot down Seventh street to Main street, thence south on Main to Fourteenth street. It is probable that the street car line on Magnolia avenue will soon be operated by electricity.

SANTA ANA, Cal.—It is reported that I. W. Hellman of San Francisco has become interested in the Santa Ana, Orange & Tustin Street Railway Company, and that the road will be changed to an electric line. The Board of Trustees has, however, declared the franchise forfeited and ordered the removal of the tracks within thirty days.

SAN FRANCISCO, Cal.—The Union Iron Works has received a contract to construct three new 1,200-horsepower engines to be placed in the Bryant street power house.—The Presidio & Ferries Railroad Company contemplates changing the steam motor line running from Baker and Greenwich streets to the beach at Harborview into an electric line as soon as the street improvements now under way are completed.

LOS ANGELES, Cal.—Application is to be made for a franchise for a $75,000 electric road to cross the Los Angeles river, Santa Fe and terminal tracks, to Boyle Heights, traversing Fourth street to Fresno avenue, terminating at Evergreen cem-

etery. The electric road from Altadena to Santa Monica will be in operation early in March. W. J. Broderick, a heavy stockholder in the Main street car line is authority for the statement that new track will be laid and electric cars be running over the main and Fifth street lines early this summer.

OAKLAND, Cal.—An ordinance has been adopted restricting the speed of street cars to eight miles an hour in the district bounded by Sixteenth, Franklin, Washington and the southerly charter line of the city and imposing a penalty of $100 for its violation.—The Oakland, San Leandro & Haywards system is building an extension of its line on Twenty-third avenue northward from Twenty-second street to the Hammond tract, a distance of half a mile.—The California Railroad Company, operating the Standard steam road from Fruitvale to Laundry Farm, has offered to equip the system with electricity if the property owners along the road will contribute $20,000, the entire change costing over $70,000.

SAN JOSE.—L. M. Hale has been granted a forty-year franchise by the Board of Supervisors for an electric railway from the western limits of the city on San Carlos street over the Saratoga road through Saratoga to Congress Springs. According to the provisions of the franchise, the road will run along the south side of the Stevens creek road and the easterly side of Saratoga avenue, and freight cars will not be permitted to run further east than the track of the South Pacific Coast Railroad. It will be standard gauge throughout, and the work of construction must commence within six months after the franchise has been awarded. All freight cars must be run at night. The road must be completed and cars running within one year from the date of the franchise. The fare is limited to thirty-five cents for the entire distance and to ten cents for three miles, and six trips each way must be made every day.—It is reported that John Center of San Francisco, who has secured possession of the Alum Rock Railway, will equip the line with electricity. The following have been elected directors of the Alum Rock Railway: J. J. Scrivener, president; Jacob Miller, J. T. Grant, Samuel Center and James N. Spence (secretary).

ILLUMINATION.

PHOENIX, A. T.—Gus Hirschfeld is to install an isolated incandescent plant.

SAN JACINTO, Cal.—A Mr. Reid of Pomona has applied for an electric franchise.

CATHLAMET, Wash.—An incandescent light plant is to be placed in Trescott's big packing house at Goble.

TUCSON, A. T.—The Tucson Gas Company has been purchased by the Electric Light and Power Company.

CALISTOGA, Cal.—A movement is on foot to put in an electric light in this city to have a capacity of 500 lights.

REDONDO, Cal.—G. J. Lindsay & Co. are reported to be contemplating the erection of an electric lighting plant here.

OROVILLE, Cal.—The Aurora mine at Magalia is to install an electric light plant for lighting the underground working.

BENICIA, Cal.—Foundations are being built preparatory to the placing of new engines in the electric light plant.

AUBURN, Cal.—A 1,000-light alternator is to be placed by the Ball Electric Company to replace the 300-light machine now used.

COLTON, Cal.—The City Council has awarded the contract for erecting the municipal lighting plant to Wilcox & Rose for $5,847.

FRESNO, Cal.—The San Joaquin Electric Company will probably light the court house and jail with about 25 incandescent lamps.

HOLLISTER, Cal.—A new Corliss engine of double the capacity of the present engine is to be placed in the electric light plant.

SANTA MONICA, Cal.—The proprietor of the North Beach Bath House contemplates installing an isolated electric lighting plant.

SAN DIEGO, Cal.—F. S. Hartwell has secured the contract for placing the 500-light incandescent plant in the Marston building.

SANTA BARBARA, Cal.—The new holder of the Santa Barbara Gas Company, which has a capacity of 30,500 feet, is about ready for use.

FERNDALE, Cal.—F. C. Nelson & Co. are installing a 45-kilowatt single-phase Westinghouse alternator for commercial lighting purposes.

REDWOOD CITY, Cal.—The circuits of the Redwood City Electric Light Company are to be extended to Menlo Park, Palo Alto and San Carlos.

SANTA ANA, Cal.—It is proposed to call a special election to vote about $1,500 bonds for the purpose of increasing the municipal lighting plant.

SAN PEDRO, Cal.—The pole line between this place and Long Branch has been completed and San Pedro will have electric lights by March 20th.

OAKLAND, Cal.—The Judson Manufacturing Company has placed twenty-four Upton arc lamps on the incandescent circuits of its isolated plant.

BANDON, Or.—The Board of Trustees is consideriing a plan of installing an incandescent dynamo in the woolen mill and to light the town thereby.

SANDON, B. C.—Samuel Lovatt is inquiring as to the cost of electric lighting plants with a view of installing a dynamo in his sawmill for lighting the town.

REDDING, Cal.—The mill and chlorination works at Hart are to be lighted by electricity from an Electrical Engineering Company's dynamo, which is now being installed.

GRASS VALLEY, Cal.—Joseph B. Kahn, formerly of the Mills building, San Francisco, has been appointed superintendent of the Grass Valley Gas and Electric Light Company.

FORT JONES, Cal.—Manuel Pereira is erecting an electric light plant using, Westinghouse apparatus, and work is progressing satisfactorily under the direction of P. F. Taylor.

GREAT FALLS, Mont.—John S. M. Neill, Surveyor General of Montana, is the principal member of a firm which has acquired the right to manufacture and use actylene in this State.

SAN FRANCISCO, Cal.—The San Francisco Gas Light Company has purchased a piece of property on the north side of Post street, between Powell and Mason streets, for $150,000 on which to erect a new building.

SAN MATEO, Cal.—The pole line for carrying the incandescent circuits of the San Mateo Electric Light Company to Belmont and on to the Belmont Military School has been completed.

ANAHEIM, Cal.—The municipal electric light plant is now being operated to its fullest capacity, and it is evident that it will soon have to be enlarged by the addition of an incandescent and arc lighting dynamo.

OAKDALE, Cal.—C. T. Tulloch, one of the proprietors of Knight's Ferry Flouring Mill, and who represents the Knight's Ferry Electric Light Plant, expects to extend his circuits to Oakdale and light the town.

FORT BRAGG, Cal.—The Fort Bragg Lumber Company has purchased a 45-kilowatt single-phase Westinghouse alternator complete, including transformer equipment. A plant will probably be installed in the Usal mill.

WILLOWS, Cal.—In retaliation for the act of the Board of Supervisors in ordering the electric lighting service in the court house and jail discontinued, the Willows Water and Light Company has discontinued rendering electric lighting service in the town.

MONROVIA, Cal.—The Monrovia Electric Power Company is making satisfactory progress in canvassing for sufficient patronage to warrant commencing work, and if the plant is installed its lighting circuits will be extended to Duarte. G. F. Buel is manager.

HANFORD, Cal.—W. H. Wilcox of Los Angeles, who is architect for the Kings county court house, favors lighting and heating the building by electricity and has drafted specfications accordingly, although provisions are made for steam or hot water heating if desired.

RIVERSIDE, Cal.—The Town Trustees have awarded the Redlands Electric Light and Power Company a contract with the city under which the company is to furnish power for all electric purposes in this city for twelve years. A similar contract has been closed with the city of Colton.

REDLANDS, Cal.—In order to develop the additional power necessary to supply the rapid extensions of its system in Riverside and Colton, the Redlands Electric Light and Power Company has ordered 3,200 feet of steel pipe which will be added to the head of the pipe line increasing the pressure from 300 to 550 feet.

SAN LEANDRO, Cal.—The $10,000 bonds recently voted for a municipal electric light plant have been sold to Hecht Bros. of San Francisco, but the sale has been temporarily enjoined by the gas company, in retaliation for which the trustees have adopted resolutions shutting off the gas lights in the streets and in all municipal departments and ordering coal oil lamps instead.

SAN FRANCISCO, Cal.—The incandescent circuits of the Parrott building are to be protected by forty Westinghouse circuit breakers of various capacities up to 1,000 amperes. The Electrical Engineering Company is building a 100-light, slow-speed, wrought iron rim dynamo for use on the excursion steamer that the Union Iron Works is building for Lake Tahoe.

SALT LAKE CITY, Utah.—Persistent rumors are afloat that the Salt Lake and Ogden Gas and Electric Light Company has bought out the plant and good will of the Citizens Electric Light Company, which, if true, will terminate the fierce war of rates that has lately been waged. Whether the report is true or not, it is definitely known that an agreement has been reached on rates.

SAN BERNARDINO, Cal.—The city authorities have made the discovery that the electric light and power company, which has been doing business for several years, has no franchise and the trustees have accordingly ordered the removal of its poles from the streets.—The San Bernardino Electric Company is endeavoring to secure additional water power by acquiring the water in Town creek.

VISALIA, Cal.—The City Council has rejected the bid of the Visalia Gas, Light and Heat Company for furnishing the city with arc lights during the ensuing year and has adopted a resolution authorizing the Mayor to appoint a committee to report upon the cost of establishing a new system of water works and an electric light plant for the city. Councilmen Hide, Brown and Levinson have been appointed as the committee named.

ALAMEDA, Cal.—The contract for the additional boiler and engines for the municipal electric light plant has been awarded to A. L. Fish, agent of the Buckeye Engine Company. The contract for erecting an addition to the station has been awarded for $1,970, and John Martin, Pacific Coast agent of the Stanley Electric and Manufacturing Company, has secured the contract for furnishing a 250-kilowatt Stanley two-phase alternator, together with all station equipments. An efficiency of 97¼ per cent is guaranteed.

BERKELEY, Cal.—It has been decided to bond the Berkeley Electric Lighting Company for $30,000, to be spent in purchase of new boilers, engines, dynamos, etc. An eighty-five-light arc dynamo has recently been added to the plant. The lighting and power plant in the mechanical engineering building of the State University is completed and the Library building is being lighted by incandescents though the arc circuits are not yet in operation. The plant comprises a 20-kilowatt Edison 110-volt generator for lighting and power purposes, twenty-five-light Sperry arc dynamo and a 500-light Westinghouse alternator.

LOS ANGELES, Cal.—E. W. Raymond of the Raymond Oil and Natural Gas Company has received a franchise to lay pipes for furnishing natural gas for fuel and heating purposes. He agrees to furnish gas at $1 per thousand and states that he is realizing 700,000 feet per day in a single well. The Los Angeles Electric Company has increased its plant by adding two new Corliss engines and four new boilers of 100 horsepower each, together with lighting generators aggregating 800 horsepower. The old switch boards have also been displaced by marble boards of the Westinghouse panel type. The plant is burning local crude oil. It is reported that Eastern hotel capitalists will erect a $100,000 hotel on the Grand View track and will light and heat the same by an electric plant.

MISCELLANEOUS.

SAN FRANCISCO, Cal.—The Electrical Engineering Company has just completed a 360-ampere plating dynamo for the California Artistic Metal Works.—The first anniversary and ball of the National Brotherhood of Electrical Workers, held on February 15th, constituted the most elaborate display of electrical decorative effects ever witnessed here. Over 1,000 incandescent lamps were woven into a network of flowers, palms and greenery so as to produce an endless variety of beautiful effects. A pendant star seven feet across hung in the center of the hall, and the initial letters of the order with the word "Welcome" was displayed in lamps representing the national colors. A monster phonograph called the dances and the twilight schottische was danced beneath a realistic moon and stars of light. The services of from twenty to forty men were employed for two weeks in preparing the display.

BERKELEY, Cal.—Some very successful photographs have been made with the Roentgen ray at the University of California through the use of a Crookes tube operated from an induction coil that in turn was supplied with single-phase alternating current at a periodicity of 233 alternations per second and which had an electro-motive force of 50 volts and about 4½ amperes, the angle of lag being 50 degrees. The best plate obtained was exposed 15 minutes, but better results were derived in an exposure of 2½ minutes than when an exposure of 1 hour was made. It is believed that much of the success achieved was due to the developer used and to the method by which the plates were developed. Th experiments were conducted by Professor Christy, who was assisted by Professor Cory and Instructors Drew and Le Conte. The plates were developed by O. V. Lange, the local photographer, who used a new developer of his own.

The "Annals of San Francisco," published in 1854, chronicles many an interesting fact now forgotten; an entry dated February 11, 1854: "The city was first lighted with coal gas on the evening of this day. The occasion was celebrated by several hundred citizens at a banquet given by the trustees of the 'San Francisco Gas Company,' in the Oriental Hotel. Already, about three miles of pipe were laid. At first, only a few principal streets and some of the leading hotels and large mercantile establishments were lighted with gas, but every day the number is increasing. The Metropolitan Theater, a few weeks after this date, adopted the new light. It will, of course, soon become general, and prove a great benefit to the city." En passant, it may be added that the price per thousand feet in that day was $15; coal, $36 to $40 per ton; labor, $6 to $7 per day, and interest 36 per cent per annum.—San Francisco Wave.

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On the Derivation of X Rays

Part I

CATHODE RADIATION.

BY FERNANDO SANFORD,
Professor of Physics, Leland Stanford Junior University.

The phenomena accompanying the electric discharge through rarified gases have furnished an attractive field for physical investigation ever since they were systematically studied by Faraday in 1838 and since 1891, the attention of physicists has been more than ever attracted to these phenomena by the

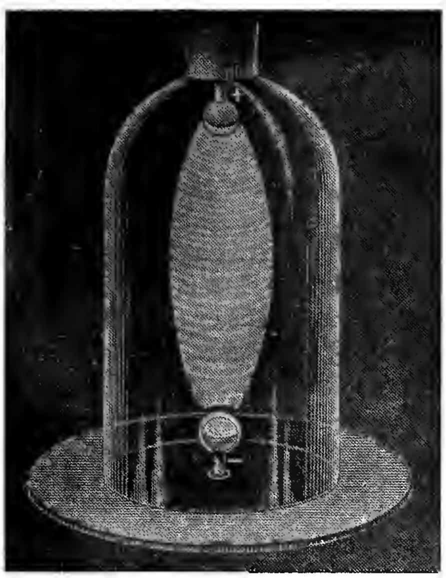


FIGURE 1—Discharge in a globe exhausted to 4 millimeters of mercury showing the stratified glow of positive light.

brilliant discoveries of Hertz and his pupil Lenard. A brief description of the different forms of electrical discharge through gases may be given somewhat as follows:

If a glass tube provided with sealed in, platinum electrodes and a stopcock for exhausting the air, have its electrodes connected to the discharging knobs of an electric machine or the secondary terminals of an induction coil while the stopcock is connected with an air pump, and if sparks be passed between the electrodes while the air is being exhausted, no change from the ordinary spark discharge will be observed until the pressure within the tube has been reduced to about 250 mm. of mercury. At about this pressure the spark discharge will be accompanied by a brush discharge, such as may be observed about a pointed conductor attached to one of the knobs of an electric

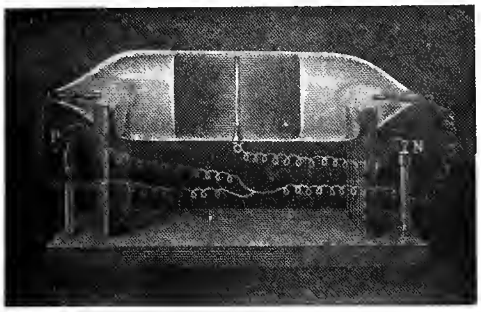


FIGURE 2—Discharge in a highly exhausted tube, showing positive light at the ends and negative glow in the center, gradually shading into the dark cathode space between the negative and positive glows.

machine. In the exhausted tube, this brush discharge will be seen only about the positive electrode. When the pressure in the tube has been reduced to about 150 mm. of mercury, the spark discharge will cease entirely, and the brush discharge from the positive electrode will take more and more the appearance of a reddish glow, and is known as the "Positive Light." This positive light spreads out more and more as the pressure in the tube is decreased, until at about 4 mm. pressure it will fill the whole tube and extend across to the negative electrode. As the pressure is still further decreased, the light appears stratified, and the interior of the tube becomes filled with alternate dark and light layers reaching across the tube perpendicular to the line of discharge. The more the pressure is diminished, the farther these layers become separated from each other.

The above can be regarded as only a very general

FIGURE 3—Highly exhausted tube for showing the rotation of a light paddle wheel under the influence of the cathode discharge.

description of the phenomena of the positive light, since the size and shape of the tube and the form and relative position of the electrodes have been found

to influence materially the appearance of the discharge. For example, the spark discharge may take place between ball electrodes at a pressure as low as 20 mm. of mercury.

The stratification spoken of is the condition usually observed in the so-called Geissler's tubes. If an induction coil or an electric machine be used to produce the effect, the positions of the dark and light strata are unsteady, and are more unsteady the farther apart and the fainter they are. If the electro-motive force be produced by a battery or constant current generator, they remain fixed in position. They are supposed to exist in all kinds of rarified gases, except, perhaps, mercury vapor. The color of the stratified positive light is, however, different in different gases. In air it is of a reddish orange color.

FIGURE 4—Highly exhausted tube in which the cathode discharge is shown bent under the influence of a magnet while the positive light proceeds undisturbed to the broken end of the tube.

If the discharge be taking place through rarified air, while the tube is yet filled with the reddish, stratified positive light, a bluish glow may be seen around the negative electrode. As soon as the pressure has fallen to about 2 mm. this reddish blue or violet glow spreads rapidly from the negative electrode (called the cathode) and is separated from the positive light by a so-called dark space in which, if the other light be screened from the eye, a faint, pale blue light may be seen. The reddish blue light is known as the cathode glow, and the darker space around it as the cathode space.

As the vacuum becomes more and more perfect, the cathode glow increases rapidly in size and pushes its darker mantle farther and farther along the tube, while the positive light recedes more and more toward the anode. Finally, when the extreme limit of exhaustion with an ordinary mercury pump is reached, a pencil of pale blue rays is seen to start from the cathode, pass through the cathode glow and the cathode space, and impinge upon the walls of the tube, or upon the anode. These pale blue rays are called the Cathode Rays. At the time when they become plainly visible in the tube, the positive light has either disappeared, or is confined to a small space about the anode, and the tube becomes practically filled with the reddish blue cathode glow and the pale blue cathode rays.

The cathode rays, on account of their peculiar properties, have recently attracted more attention than the other kinds of light in the tube. Some of the properties of these rays may be briefly mentioned.

The first thing to strike the attention of the observer is the fact that they seem to go out in straight lines in all directions perpendicular to the surface of the cathode, and seem to be but little influenced in their direction by the position of the positive electrode. In fact they may be made to go off through the tube in a direction opposite to the anode. On account of their leaving the cathode perpendicular to its surface, they will form a beam of parallel rays if the cathode surface be a plane, or they will converge to a focus and diverge after passing through this focus, if the cathode surface have the form of a concave mirror. They usually carry with them small metallic particles from the cathode which are deposited upon the glass and form a metallic mirror where the rays impinge upon it. It has been found that aluminum is less volatilized by the cathode discharge than other metals, and that the particles do not adhere to the walls of the tube where they strike upon them, and the electrodes of tubes prepared for the observation of cathode radiation generally have their discharging surfaces made of aluminum.

There is no observable reflection of cathode rays from the walls of the tube, or from any surface upon which they may be made to impinge. A metal plate is heated by them. The glass walls of the tube are generally made to glow with a fluorescent light when the cathode rays beat upon them. In the German glass of which such vacuum tubes are generally made, this fluorescence is of a bright green color. It is especially marked in uranium glass, in which the color is of a darker green than in German glass. If brought to a focus upon the glass walls of the tube, they may heat the glass sufficiently to cause a puncture of the tube. If they are made to strike against the mica vanes of a small paddle wheel, they set the wheel in rapid rotation. They are deflected from their straight paths when brought into a strong magnetic field, and are bent toward a direction at right angles to the magnetic lines of force. If they be regarded as made up of moving particles going out from the cathode, these particles are made to revolve about the magnetic lines of force in a direction opposite to the Amperian currents. Two parallel beams of cathode rays repel each other, like chains of similarly electrified particles, instead of attracting each other like parallel currents flowing in the same direction.

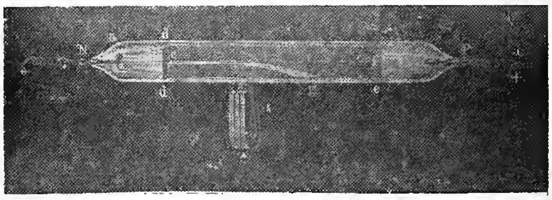


FIGURE 5—Highly exhausted tube containing a fluorescent screen along which the cathode radiation is bent from "e" to "g" by the magnet beneath the tube.

The above mentioned phenomena of cathode radiation are practically all discussed in the papers written by Hittorf in 1869, and by Crookes in 1879. In 1891, Hertz observed that the cathode rays could apparently be passed through thin metal foil and other opaque substances and still have sufficient energy to produce fluorscent effects. He observed also that if the rays are parallel before falling upon the metal foil, they are dispersed and rendered divergent by their passage through it.

In 1893, Philip Lenard prepared a vacuum tube with

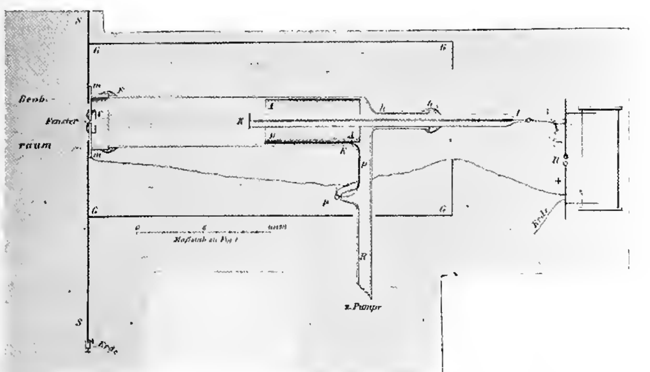


FIGURE 6—Cut of the lamp used by Lenard, showing an aluminum window at "V," which is connected with the earth and to the positive electrode.—Wiedemann's Annalen, Jan. 15, 1894.

a window 1.7 mm. in diameter at one end, over which he cemented a piece of aluminum foil about .003 mm. thick. When the cathode rays were directed against this window, they seemed to pass through it and to be dispersed in the outer air. Lenard was able to recognize their fluorescent effects upon various substances at a distance from 6 to 8 cm. from the window when using the discharge from an induction coil capable of giving a spark 15 cm. long in air. He found that the effect was equally strong in all directions from the aluminum window, showing that the radiation spread out in all directions after passing through the window into the outer air. He discovered also the photographic effect of these rays. He observed that ordinary photographic printing paper when placed near the window was blackened by these rays as rapidly as by the sunlight on a cloudy day. A sensitized plate when exposed to the rays (which gave no luminous effect in the air) at a much greater distance from the window for a few seconds and afterward developed was found to be blackened as if it had been exposed to sunlight. Lenard made photographs with these rays through opaque card board and through thin metal foil with an exposure of only two minutes, and observed the shadow images left upon the plate when thicker pieces of metal were laid upon it

He repeated these experiments with the rays which had apparently passed through the glass walls of his tube, but found their intensity to be less than when they had apparently passed through the aluminum window.

Lenard also passed the cathode rays, as he supposed, through the aluminum window into a vacuum tube exhausted to such a degree that no discharge could be passed between electrodes sealed into the tubes, and found them capable of producing in this tube all the effects produced by them in the tube in which they were originally generated, and in the outer air. He found that a large part of the dispersion formerly observed in the atmosphere was due to the presence of the air, so that a beam of parallel rays passed through the window into the vacuum became a moderately diverging pencil. He found them still capable of deviation by a magnet, and observed that the magnitude of this deviation remained unaltered when air was admitted to the tube, until the absorptive effect of the air made further observation impossible. He measured the magnetic deviation at air pressures varying from 31 mm. to .02 mm., and in hydrogen from 3.32 mm. to .02 mm., and found it to be the same in all cases, regardless of pressure. He observed that neither in a vacuum nor in the air were the rays capable of reflection from any kind of a surface.

Later, in 1895, Lenard tested the absorptive power of many substances, solids, liquids and gases, for the cathode rays, and found the absorptive power of different substances to be proportional to their density, irrespective of their chemical nature.

In 1894, J. J. Thompson observed the phosphorescent effect of the cathode rays upon a piece of ordinary German glass at a distance of several feet from the vacuum tube, even when the rays had to pass through the glass walls of the tube. He measured the velocity of cathode radiation in the tube by observing by means

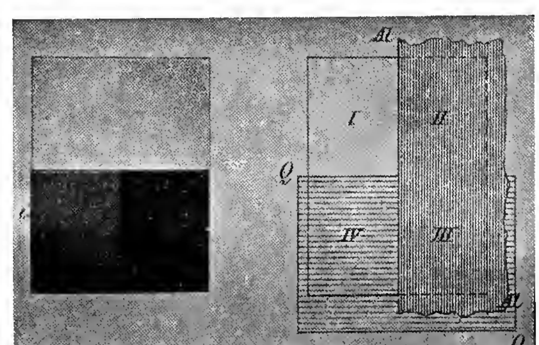


FIGURE 7—"A" represents a photograph taken by means of the apparatus in Figure 6, the radiation passing through the crossed sheets of aluminum and quartz, arranged as shown in "B."

of a rapidly rotating mirror the difference in time of the beginning of the phosphorescent effect upon two spots ten centimetres apart upon the glass wall of the tube when a discharge was passed between the electrodes. He found the velocity in a tube of rarified hydrogen to be 1.9×10^{7} cm. sec., or about 100 times the mean velocity of the hydrogen atom at O. C.

In December, 1895, Roentgen announced that he had

observed the fluorescence of a paper screen prepared with a solution of the double cyanide of barium and platinum when it was placed at a distance as great as two meters from a tube in which the cathode discharge was taking place, even when the tube was covered with a screen of opaque paper. By placing dense bodies between the screen and the tube their shadows were plainly visible upon the screen. When the hand was held between the screen and tube, the denser bones were plainly outlined in shadow through the more transparent flesh. Upon exposing a covered photographic plate to the action of the rays which produced the fluorescence, as Lenard had previously done, he was able to develop photographs in which the bones of the hand and other dense bodies were plainly outlined in shadow.

Roentgen passed these rays through prisms of various liquids, of hard rubber and of aluminum, without producing any noticeable refraction. He was unable to reflect them from any surface, and he found that different metals in a finely divided form were as transparent as the same metal in a solid form, showing that there could be but little reflection at each metallic surface. He was unable to produce any magnetic deflection of the rays, or to polarize them. He also found that while their absorption increased with the density of the absorbing body it was not independent of the chemical nature of the body. He found on comparing the transparency of equally thick plates of glass, aluminum, quartz and calcite, all of which are nearly of the same density, that while the first three were nearly alike in their transparancy, the calcite was much more opaque.

These observations have all been repeated by many other physicists under widely varying conditions, and their accuracy can not be questioned.

Roentgen accordingly believes that he has been experimenting with a radiation different from the one which Hertz and Lenard supposed to be the cathode rays after they had been passed through glass or other substances. Since, however, the conditions of the experiments were the same in both cases, it seems certain that if Lenard and Roentgen have been experimenting with two different kinds of radiation, both kinds must have been present in all the experiments performed by either. The probability that different kinds of cathode radiation may exist at the same time in the tube has been previously mentioned. Goldstein, more than ten years ago, mentions the fact that while part of the cathode rays are deflected by the magnet, they exist with these others which are not capable of magnetic deflection. Lenard also calls attention to the fact that the degree of magnetic deflection of which the cathode rays are capable depends upon the degree of exhaustion of the tube in which they are produced. Roentgen has also called attention to the observation that the "X rays" seem to come from the part of the tube directly facing the discharging surface of the cathode, even if the visible cathode rays are deflected by a magnet to another part of the tube.

The differences in the experimental results of Lenard and Roentgen are not, however, sufficiently great to make it certain that they have been working with different kinds of radiation. These differences are, principally, that while Lenard found the atmosphere to act as a turbid medium for the transmission of his rays, Roentgen has found it to be apparently very transparent to the passage of the X ray, and while Lenard was able to show that the magnetic deflection of his rays was constant up to a pressure of 31 mm. in air, Roentgen and others have failed to find any magnetic deflection in air at a pressure of 760 mm. Roentgen has also found that while absorption is, in general, proportional to the density of the absorbing body, there are substances in which this is not the case. In other respects, so far as both kinds of radiation were tested, they have the same properties, and Roentgen, in his photographic effects, has only repeated on a larger scale the work previously done by Lenard.

The differences between these rays and other known forms of radiation are, however, more marked. These differences, as stated by Roentgen, are as follows:

(a) All other known forms of radiation are refracted when passing obliquely from one medium into another of different density.

(b) All other known forms of radiation can be regularly reflected from polished surfaces.

(c) All other known forms of radiation can be polarized.

(d) The absorption of all other kinds of rays depends more upon other properties of the absorbing medium than upon its density.

Since these differences are so marked, Roentgen asks if these rays may not be due to longitudinal vibrations in the ether.

The fact that they differ so greatly in some of their properties from the cathode rays within the tube has led Roentgen to the belief that they are set up in the walls of the tube by the impact of the cathode rays. This assumption gains in probability from the report that J. J. Thomson has tried to produce the same photographic effect by means of the cathode rays while in the tube and has failed. The reported results of different observers who have tried to determine the source of the rays are very conflicting, and it is probably not too much to say that their origin is still unknown. The probability of their being waves of longitudinal vibrations is somewhat strengthened by the fact that the present writer, in 1892-3, produced similar photographic effects in an oscillating condenser field where the vibrations were certainly of a longitudinal character.

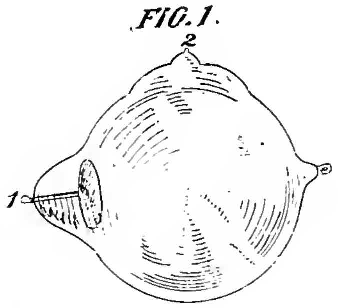
Part ii

ANODE RADIATIONS.

BY PHILIP MILLS JONES, M. D.

I commenced some investigations on the rays of Roentgen about the middle of February, and as the results obtained have been satisfactory, and in some lines, so far as I know, original, it has seemed to me advisable to place on record my data and the conclusions which I have deduced therefrom.

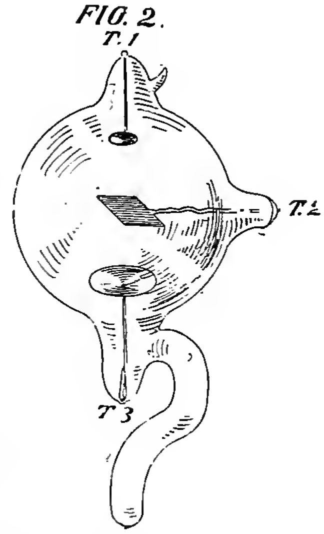
FIG. 1.



My electrical apparatus consists of an induction coil which, with seven volts in the primary, will give a four-inch spark in air. The interrupter is of the magnetic type, and gives about forty to sixty interruptions per second. The coil is energized by three storage batteries.

No standard Crooke's tube was obtainable when the work was commenced so I had recourse to Mr. L. G.

FIG. 2.

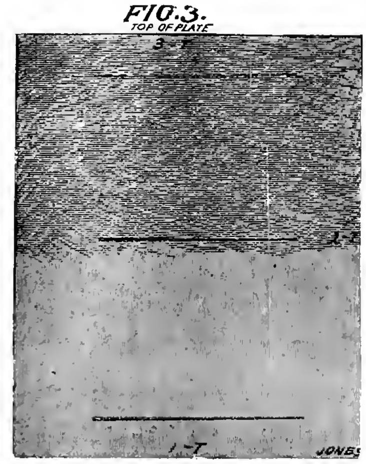


Lamont, a skillful glassblower and manufacturer of small lamps. Mr. Lamont had made no Crookes tubes, but between my suggestions and his skill we managed to produce a vacuum tube that gave results. The tube was generally spherical, with the terminals in the form of platinum disks one half inch in diameter, set at right angles (Figure 1), and which I shall, for reference, refer to as T_1 and T_2. The tube was of sufficiently high vacuum to give a brilliant green fluorescnce opposite the cathode.

This tube was suspended over a plate-holder containing the plate, on the slide of which were several metallic objects. The terminal T_2 was over the center of the plate and parallel to it, while terminal T_1 was in a plane verticle to the sensative plate and at right angles to T_2. Terminal T_2 was connected to the cathode

FIG. 3.

TOP OF PLATE



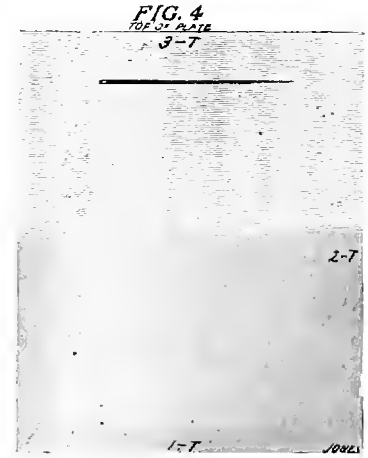
of the coil and a brilliant patch of fluorescence appeared opposite and on the glass directly over the plate. No result was obtained in any one of a dozen or more exposures of from an hour to two and one-half hours.

Then the poles were changed, terminal 1 was made cathode, the green patch appearing opposite it, and the plate exposed for one and one-half hours opposite T_2 (the anode), gave a fairly good negative of the objects on the plate-holder.

That was on February 18th, and at once I concluded

FIG. 4

TOP OF PLATE



that the X rays were anode rays, or that the phenomena of vacuum tube polarity had been erroneously named. Further investigation has shown that the former was the correct conclusion, and that the X rays of Roentgen are of anode emanation.

After a few days a genuine Crookes tube of fairly high vacuum came into my possession, through the courtesy of the Santa Clara College. Drawing sug-

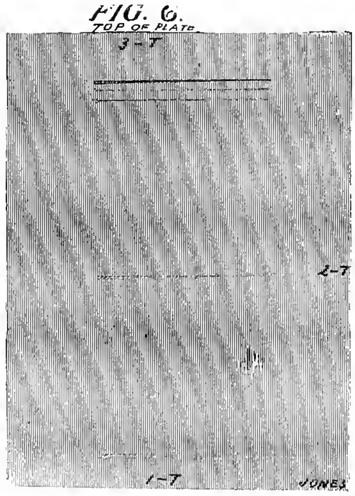
gestions from this tube Mr. Lamont has succeeded in perfecting vacuum tubes for producing the X-ray effects.

This tube (Figure 2) is of the same pattern as those used by Elihu Thomson and several other experi-

FIG 5

menters. It contains three terminals, which, for convenience, are numbered 1, 2 and 3—as in the cut (Figure 2). Terminal 1 (T_1) is an aluminum disk one-half inch in diameter; T_2 is a platinum plate one-half inch wide and five-eighths inches long; T_3 is a cup-shaped aluminum disk, with its focus at T_2. With this tube I noticed at once that the best results were obtained when the tube was so placed and connected that emanations from the anode were directed against the plate. But press of work prevented my going into the question for some little time. The work first taken up was largely investigating the extent to which the X rays would be useful in surgery and in testing plates

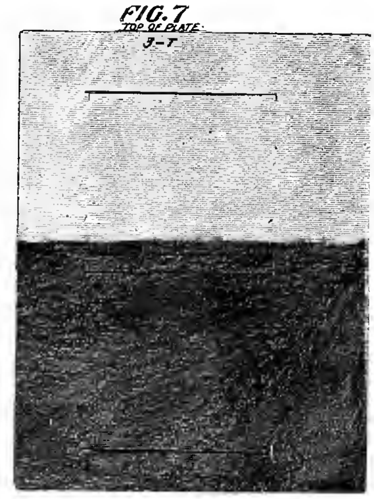
FIG. 6.



and developers, and in obtaining standards for comparison.

From time to time, as opportunity offered, I made rough tests to determine the point of origin of the rays by calculating the angles of distortion, and in every case the anode was the terminal which seemed to be responsible. With the tube verticle, T_1 down and connected so that T_1 was cathode and T_2 and T_3 anodes, the best results were obtained and the distortion was least. If, however, the polarity was reversed and T_1 made anode, with T_2 and T_3 cathode, the results were not good—longer exposures were required and great distortion resulted. With the tube in the position and

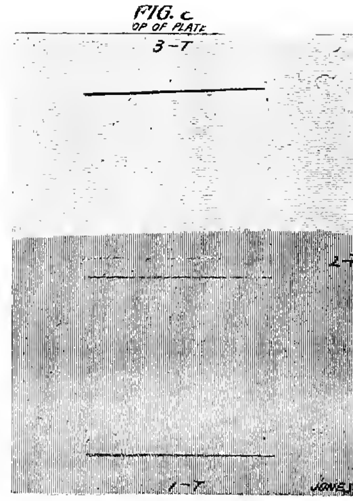
FIG. 7



with the connections first noted fair negatives have been obtained in thirty seconds, and good ones in one or two minutes. But I found my experience to be the same as that of Nikola Tesla, recently published, that while it is quite possible to get negatives in a few seconds or minutes, to obtain a good negative requires from fifteen minutes to one and one-half hours.

As soon as possible I commenced regular work on the investigation for the actual source of the X rays. It was evident that first I must know what effect would be produced by differences in the connections and direction of current; as will be seen, the three

FIG. 8

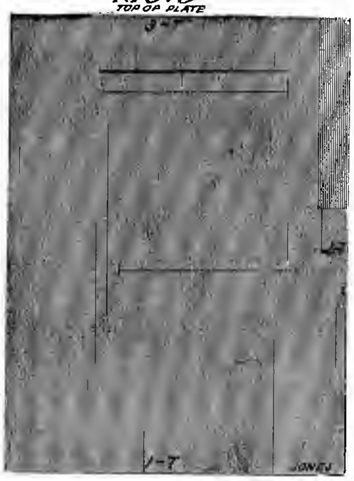


terminals admit of twelve possible combinations, and the effect of each one must be known. The experiments were made as accurately as possible; all conditions were as nearly the same as could be obtained. The plates were all of the same kind and the same emulsion; the relations between plate and tube were measured and adjusted several times, with rule and plumb line; the developer used was the same; the time

of development varied only one and one-half minutes, and was in most cases the same—three minutes.

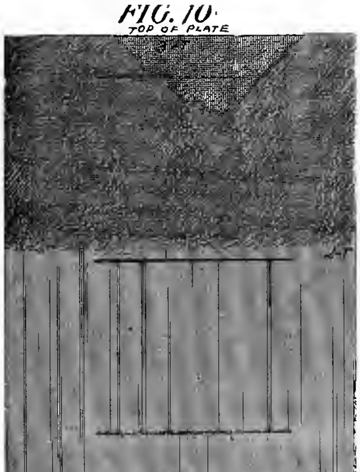
The tube was placed horizontally, with its line of center four and five-eighths inches from the film of the sensative plate; it was rigidly clamped in this position. The plate (4x5) was placed so that T_2 came over the center of the plate and the axis of the tube was parallel to the long edges of the plate. T_3 was over that end of the plate which will be throughout referred to as the "top of the plate." The plate-holder was fitted into thin strips of wood nailed to the table, so that it would in all cases have the same position with relation to the tube. The distances of the terminals apart is one and one-half inches; i. e. T_1 to T_2—one and one-half inches; T_2 to T_3 —one and one-half inches; T_1 extends one-quarter inch, T_2, one-half inch, and T_3 three-quarter inches from the axis of their centers.

FIG. 9
TOP OF PLATE



The objects used were needles, three in number, each thrust through a cork in such a manner that they would be parallel to the plate surface and five-eighths of an inch therefrom. They were, for accuracy, pasted to a sheet of stiff paper which exactly fitted the plate-holder slide. The needles will be referred to as N_1, N_2 and N_3; N_3 being at the top of the plate, or under T_3.

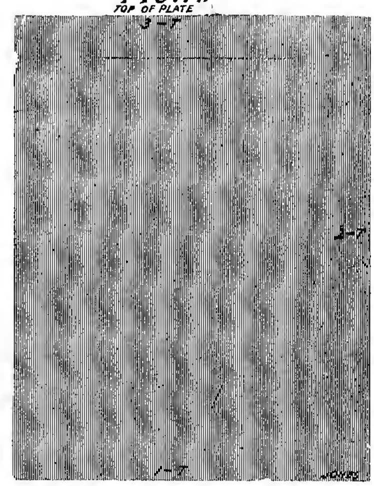
FIG. 10
TOP OF PLATE



T_3 was centered exactly over N_3. The needles were parallel to each other and one and five-eighths inches distant one from the next adjoining.

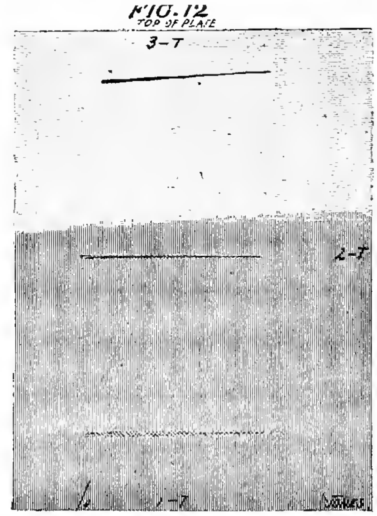
The exposure was in every case (except in subsequent work when some of the first twelve experiments were repeated) fifteen minutes. A slight variation in the intensity of the X ray effects was unavoidable, owing to a warming of the coil and a decrease of voltage of the batteries after several hours more or less continuous use. This variation, however, is not of particular import, for subsequent repetitions of the first twelve experiments do not show anything more than a slight increase in the density of the film; the positions or absence of shadows is the same.

FIG. 11
TOP OF PLATE



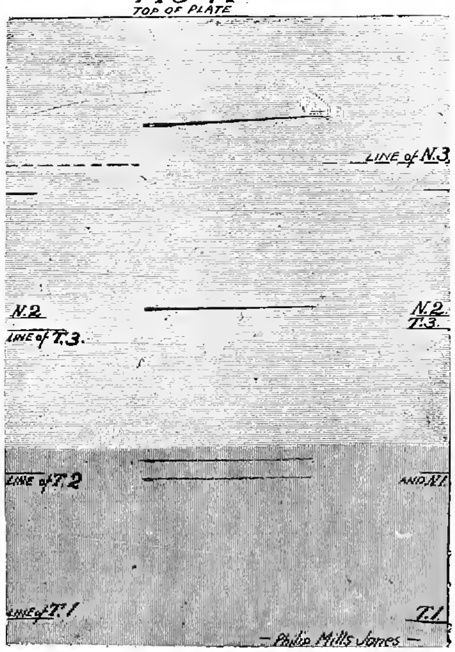
Experiment 1, with T_1 cathode and T_3 anode, gave the plate shown in Figure 3. Shadows appear at N_1, one-quarter inch below the proper place; N_2 centers, N centers, while N_1 and N_3 are not sharp, especially N_3. The lower half of the plate is more dense than the upper; the line of demarcation is quite sharp and is along the line of the center of the plate. Shadows of N_1 and N_2, if the angles are projected back, are found to be produced by rays from T_2. The shadow of N_3 is made by rays from T .

FIG. 12
TOP OF PLATE



Experiment No. 2, with T_1 anode, T_3 cathode, gives plate as show in Figure 4. There are no shadows of N_1 or N_2. N_3 is sharp and one-quarter inch above (toward T_3 the location of N_3 The top half of the plate, from a point three-eighths of an inch above the

FIG 14.



line of center, is denser than the lower half and is also denser than the lower half of the plate in experiment No. 1. Shadow of N_3 was found to be produced by rays from T_2.

In experiment No. 3 with T_1 cathode, T_2 and T_3 anodes (this is the method of connection I have used for all my general X-ray work, as being most satisfactory), plate 1 (Figure 5) shows the shadow of N_1 to be one-quarter of an inch below position N_4. N_2 centers, N_3 casts two shadows, one of which centers but is blurred and indistinct, and the other is one-quarter of an inch above the position of N_3, and is sharp, though faint. The plate is dense in the lower half (being of the same area as the plate used in experiment No. 1, but much more dense). The shadows of N_1 and N_2 and one shadow of N_3, are cast by rays from T_2; one shadow of N_3 is cast by rays from T_3.

Experiment No. 4, with T_1 as anode, T_2 and T_3 as cathodes, gave a blank plate (N. B.—The tube was not so active in this experiment as in the others. A repetition with the tube active, however, gave only a faint shadow of N_1, which was in its proper place).

Experiment No. 5, with T_1 and T_2, as cathode, and T_3 as anode, gave the plate shown in Figure 6. Negative is of even density, with shadows as follows: N_1 is one-half inch below the location of N_1, N_2 is one-quarter inch below location of N_2. N_3 gave three shadows, (1) centers, (2) one-eighth inch above the proper place, and (3) one-quarter inch above the proper place. The shadows of N_1 is thrown from T_3, of N_2, from T_3 of N_3 there are two shadows (1) that centers, and one one-eighth inch up from T_3, while the third shadows of N_3 evidently comes from T_2.

Experiment No. 6, with T_1 and T_2 as anodes and T_3 as cathode, gave the plate shown in Figure 7. This plate, from three-eighths inch above the line of center to the top is very dense; the shadow of N_1 is one-quarter inch below N_1, but sharp. N_2 gives two shadows, one of which centers and one is three-sixteenths of an inch above N_2. The N_3 shadow is one-fourth of an inch above N_3. The shadow of N_1 is cast by rays from T_2. If the shadows of N_2 are cast by rays from T_1 and one by rays from T_2, the shadow of N3 is cast by rays from T_2.

Experiment No. 7, with T_2 as anode and T_3 as cathode, gave the plate in Figure 8. This plate is dense from about one-half an inch above the line of center to the top of the plate. Shadow N_1, one-fourth of an inch blow N_1. N_2 cast two shadows, one centers and one one-fourth above N_2. The N_3 shadow is one-fourth of an inch above N_3. The shadow of N_1 is cast by rays from T_2; in that of N_2 one shadow is made by rays from T_1 and one by rays from T_2; of N_3 by rays from T_2.

Experiment No. 8, with T_3 as anode and T_2 as cathode, gave the plate on Figure 9. The plate for the same distance from center to top is slightly denser than in the lower part. There is no shadow of N_1; a very faint shadow of N_2, one-fourth of an inch below N_2; two shadows of N_3, the faint one centers and the other is clearer, one-fourth of an inch above N_3. The shadow of N_2 is thrown by rays from T_3 one shadow, N_3, is by rays from T_3 and one by rays from T_2.

FIGURE 15—A Pin Hole Negative.

Experiment No. 9, with T_1 as cathode and T_2 as anode, gave the plate in Figure 10, which, from a little above the line of center to the bottom, is slightly denser. The shadow of N_1 is blurred, though plain, and one-fourth of an inch below N_1; the shadow of N_2 centers, and that of N_3 is one-fourth above. All three shadows are thrown by rays from T_2.

Experiment No. 10, with T_1 as anode and T_2 as cath-

ode, gave a blank plate. (Note. The tube was again not fully excited; a repetition of this experiment at a subsequent date give a faint shadow of N1 in the proper place.)

Experiment No. 11, with T_1 and T_3 as anodes and T_2

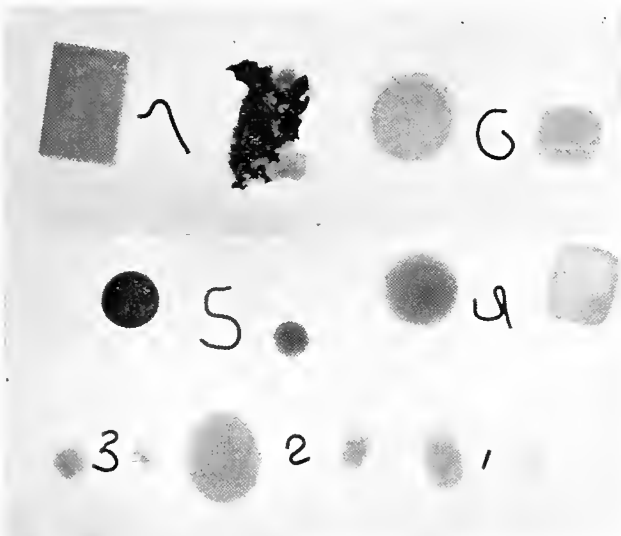


FIGURE 16--Illustrating the relative sensity of precious stones.

as cathode, gave the plate in Figure 11, which is of even density, and showing the shadow of only one needle; N_3, which is one-fourth of an inch above the location of N_3. The shadow in this case must have been thrown by rays from T_2.

Experiment No. 12, with T_1 and T_3 as cathodes and T_2 as anode, gave the plate Figure 12, which is very dense from the same line to the top. The shadow of N_1 is blurred, though very plain, one-fourth of an inch below N_1; of N_2 the shadow is sharp and centers; of N_3 it is sharp and one-fourth of an inch above the position of N_3. All three shadows must have been thrown by T_2, as can be seen by projecting out the angles of distortion.

Many, in fact most, of these experiments have been repeated several times—some of them as many as ten or twelve times. To see whether the obvious conclusions to be drawn from them were substantiated by other tests, another series of experiments was made, the second form of experiments being, if anything, more striking in their results.

The tube was arranged vertically, with T_1 down. A plate in a plate holder was placed perpendicularly, parallel to the long axis of the tube, and with its central point in the plane of T_2. Both tube and plate were equidistant from a sheet of lead in which was a hole three-sixteenths of an inch in diameter, and on the plane of T_2 the center of the plate. As lead cuts off almost all the X rays, it will be obvious that the resultant negative would be a "pin-hole" picture, giving the source of emancipation of the X rays.

This experiment was made ten times, with several different arrangements of anode and cathode, and the results were strikingly similar. In every case T_2 threw a heavy shadow, whether it was connected to the anode or not; in no case did any terminal which was connected with the cathode throw the faintest shadow; the anode terminal always threw a shadow, but if it were T_1 or T_3 it was not so dense as that from T_2.

Figure 15 is one of these "pin-hole" pictures, with the tube connected so that T_1 and T_2 are anodes and T_3 is the cathode. No X rays came from T_3 and but few from T_1, while the very heavy shadow of T_2 shows that the maximum number of X rays emanated from that point.

Figure 14 shows the distortion much more clearly, and was made on a 5x7 plate with the object of gettng more angles for projection. The tube was connected with T_1 and T_2 as the anode and T_2 as the cathode, and T_3 as the cathode and was arranged as in experiments 1 to 12, except that N_2 was exactly centered under T_2. The distances were afterward carefully measured and the positions of the terminals and needles marked on the plate. N_1 threw two shadows, one from T_1 three-sixteenths above N_1, and one from T_2, exactly centering in its proposed plane. The shadows of N_2 and N_3 were both thrown by rays from T_2, as can be readily seen by projecting the angles of distortion.

These experiments with their many repetitions and slight changes seemed to furnish a mass of very confused and contradictory testimony. From this confusion, however, I have evolved some order, and have de-

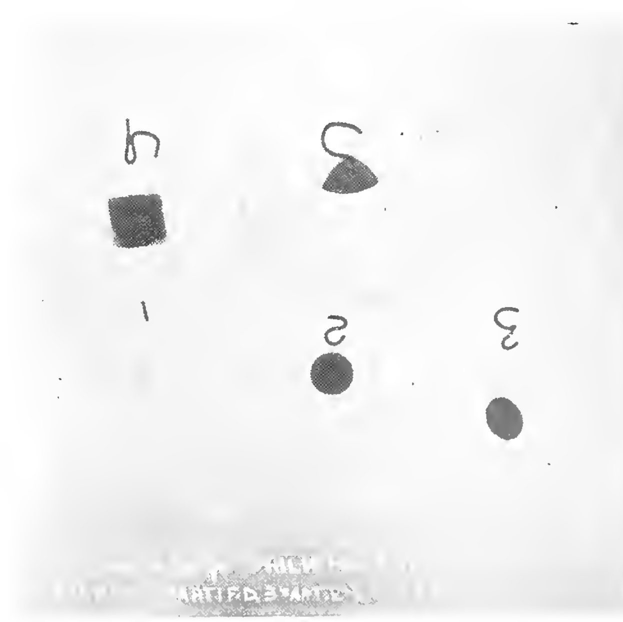


FIGURE 17--Illustrating different opacity of genuine and artificial gems.

duced several general principles, the truth or falsity of which will undoubtedly be more manifest within a short time.

First.—That the X rays do not emanate from the glass, as advanced by Roentgen. This has been shown also, by J. J. Thomson, Lodge, Professor Rowland, and

others. If the X rays did emanate from the glass at any point, that fact would be made known by the pin-hole experiment; also the distortion would always be considerable, unless the tube were placed at some distance (several feet) from the plate.

Second.—The X rays do not emanate from the cathode terminals, as Figures 6-9-11 would at first glance seem to indicate. This point will be dealt with later. Professor Rowland, Elihu Thomson, J. J. Thomson and others have in various ways demonstrated the absence of X ray effects from the cathode. All my experiments (with the exceptions above noted) and all "pin-hole" experiments, substantiate this contention. No X rays emanate from the cathode, per se.

Third.—A certain number of X rays emanate from the anode, irrespective of position of the cathode. In every combination of the connections in the tube Figure 2, some X ray effects are produced by the anode. In tubes made with the terminals at right angles and so constructed that few if any cathode rays can strike upon the anode, as the tube in figure 1, X rays are found to emanate from the anode.

Fourth.—The number and intensity of the X rays emanating from the anode, per se, seem to increase directly with the vacuum and the current tension. With a tube similar to Figure 1, but a low vacuum—just high enough exhaustion to produce cathode rays—feeble X ray effects are obtainable with the anode terminal dirctly above and parallel to the plate. With the anode perpendicular to, and the cathode stream directed upon the plate, no X ray effects have been produced even after several hours' exposure. With vacuua of higher exhaustion feeble X ray effects may be produced with this arangement.

Fifth—(a) X rays emanate from a metal plate within the tube, which is not connected to either pole, but against which the cathode rays are projected; (b) and the greater theintensityand concentration of the cathode rays upon the unconnected metal plate, the greater the number and intensity of X rays which emanate here from. (a) In plates 3, 4 and 8, this effect is clearly shown. (b) Plates 3 and 4, and other similar experiments, show that the greater X ray effect is invariably obtained from T_2, when T_3 is cathode—in other words, when the stream of cathode rays is concentrated upon it by the large cup-shaped terminal. More than a dozen experiments on this line have been made, the results being constant. It does not make the slightest apparent difference whether T_2 is grounded by means of straight wire or through a large coil where the self-inductive effect would be considerable. This fact has not heretofore been noted.

Sixth.—An unconnected metal plate within the tube may project X rays where it is not connected to either terminal, and when a metal plate intervenes, cutting off the cathode rays. This is shown in plate 8, excepting No. 7, where the second shadow of N_2 is thrown three-sixteenths of an inch up, showing that the source of rays making the shadow was T_1. Yet T_1 was not connected, and T_2 cut off all apparent cathode rays from striking upon T_1. It would, however, be possible for T_1 to become charged by the stream from T_2.

Seventh.—X rays are produced in their maximum quantity and intensity at, and emanate from the anode, when the cathode rays are focused upon the anode terminal. Figures 5, 7, 8, 10 and 12 show this pretty conclusively. It is to be noted that invariably that half of the plate is more dense which is on the side of T_2, facing the cathode and receiving the cathode stream and that when T_1 and T_3 are both cathode the side of T_2, which faces T_3, projects the greater number of, or the more intense, X rays.

The foregoing seven deductions, I think I am thoroughly warranted in making, but the following, however, admits of dispute:

Eighth.—That the X rays, focused upon a cathode terminal, are reflected therefrom. Figures 6, 9 and 11, in experiments 5, 8 and 11 show shadows thrown by rays which must have been projected from T_2, while T_2 was connected to the cathode.

On March 16th and again on March 28th, I had the pleasure of going over my work with Professor Sanford, who is of the opinion that the deductions drawn from the results, as set forth, are justified, with the possible exception of the eighth, which needs more confitmation. On March 18th I informed Professor Cory of the University of California of the nature of my investigations and conclusions. He has subsequently made several experiments along the same line, with results that substantiate my own.

It seems clear, then, that we have: (a) some X rays emanating from the anode uninfluenced by the cathode; (b) more from an unconnected plate of metal, in the tube, which is situated in the path of both anode and cathode raye, and (c) the maximum intensity when the cathode rays expend their energy upon the anode, and preferably are focused upon the anode. These facts would seem to indicate that the X ray has its origin at a metal within the vacuum which is in a state of oscillatory electrification, with the positive in preponderance and are longitudinal ether waves.

The theory advanced by Thomson, Lodge, Hicks, and others, that the X rays emanate from the first solid upon which the cathode rays impinge, it seems to me clearly disproved by the experiment of J. J. Thomson. He enclosed a wrapped sensatized plate within the vacuum so arranged that the cathode rays impinged upon it. The plate was unaffected.

The plate in Figure 16 shows the relative density of several precious and semi-precious stones. They are, in the order named, as follows: Diamond, 1. opal, emerald, 2 jade, ruby, 3 sapphire, sard, 4 amythist, pearl, 5 enamel, bloodstone, 6 white onyx, quartz, 7 sardonyx.

Figure 17 shows the difference in opacity to the X

rays, of a genuine diamond and several artificial stones and illustrates one use to which the X rays may be put. The genuine and artificial diamonds were almost exactly the same size and were exactly the same weight.

Part iii

DEDUCTIONS FROM DR. JONES' EXPERIMENTS.

BY FERNANDO SANFORD,
Professor of Physics, Leland Stanford Junior University

I have watched with much interest the results of the very intelligent and accurate work of Dr. Philip Mills Jones on the determination of the source of the Roentgen rays. Some of Dr. Jones' experiments were performed in my presence, and I have had the pleasure of examining all his negatives in the presence of the apparatus by which they were made. The great care taken in all the details of the experiments renders the work of special value in helping to settle the puzzling question of the source of the photographic and fluorescent effects to which Roentgen has called the attention of the world. Dr. Jones' first experiment with the lead plate camera was performed in my presence and at my request, and the result seemed to point conclusively to the anode as the source of the Roentgen rays. His later experiments, together with his former experience in making photographs by means of a tube in which the electrodes were inserted at right angles to each other, all seem to show that few, if any, of these rays originate at the cathode, or in the glass upon which the cathode rays impinge. They may originate at the anode, whether the cathode rays do or do not impinge upon it, and they may originate upon it, and they may originate upon an insulated or uninsulated metal plate placed in the pathway of both the cathode and anode discharge. In this event they are much stronger from the side of the plate turned toward the cathode. The most favorable condition for their production seems to be when the plate from which they proceed is made the anode and the cathode rays are focused upon it by means of a concave cathode.

Under all the circumstances of their production, as shown in Dr. Jones' experiments, they have their origin upon á conductor which is being alternately, positivly and negatively electrified. There can be no question as to the oscillatory character of its discharge in the vacuum tube, and of the consequent alternating electrical condition of the anode when the cathode is discharging directly upon it. The same thing would be true, to a less extent, of the metal plate in the pathway of the two discharges. The condition of the anode would, accordingly, be similar to that of one of the plates of a condenser placed in contact with the terminals of an induction coil while a spark is passing between these terminals.

That a plate so connected is capable of producing photographic effects similar to those produced by the anode in the vacuum tube was shown by me in 1893. Since the publication of Roentgen's paper I have produced similar effects through a block of paraffine two centimeters thick placed between the plates of a condenser attached to the terminals of an induction coil while the coil was giving a spark two to three centimeters long in air. A key imbedded in the paraffine block gave a shadow exactly corresponding to the Roentgen shadows, but when placed very close to the plate, being separated only by a thin sheet of mica, gave a negative photograph of itself upon the plate, even when separated from the condenser plate by the block of paraffine above mentioned. In this condition it seems to correspond to the plate between the anode and cathode in the vacuum tube, but its effect in sending off waves was apparently very weak as compared with the condenser plate.

I have also made shadows of a thin sheet of mica laid on the photographic plate under the paraffine block, showing that mica is more opaque than paraffine to the passage of the vibration between the condenser plates.

Since these conditions correspond so closely with the condition of the conductor which sends off the Roentgen rays. I cannot but think that both kinds of waves are essentially of the same character, in which event the Roentgen rays are similar to the longitudinal vibrations in an oscillating condenser field.

Physics

THE DETERMINATION OF A LIGHT UNIT.

BY D. W. MURPHY.

Within the past few years the determination of a light unit which should be suitable as a standard with which other light sources could be compared, has received no little attention in the scientific world. We are accustomed to define the amount of light given off by a source as being equal to that of some number of standard candles, by a standard candle meaning one that consumes a unit mass of wax, paraffine or other combustible substance in a unit of time. The amount of light from such a standard is necessarily a variable quantity, as it depends upon the purity of the substance consumed, and, as is the case with all flames, upon the meteorological conditions of the atmosphere. The former source of error can be reduced to a minimum by using a more defined substance; and corrections based upon experimetal data can be made for atmospherical changes, reducing the results to standard conditions. The final test, however, for such a unit as a standard, is whether in the hands of different observers concordant results can be attained. This has not been attained by any form of candle yet used. Meas-

urements upon a paraffine candle in use for many years and adopted as a standard in Germany show that these variations were not less than 10 per cent.

The principal requirements of a light unit that will be serviceable as a standard are, first, that it shall be constant, and second, that it be simple enough in construction that it may be readily reproduced. The first requirement is one of a purely scientific nature, and may aid in the solution of the problem from a practical standpoint just in proportion as the second requirement can be realized. Since no standard yet prepared has given constant results in the hands of different observers, various attempts have been made to find some more reliable source with which comparisons can Vernon Harcourt. These are both open flame lamps, be made. To this end various light units have been proposed; among the most prominent of these should be mentioned the Heffner lamp and the pentane lamp of the substance used in the first being amyl acetate and in the second pentane. M. Vioele has proposed as a

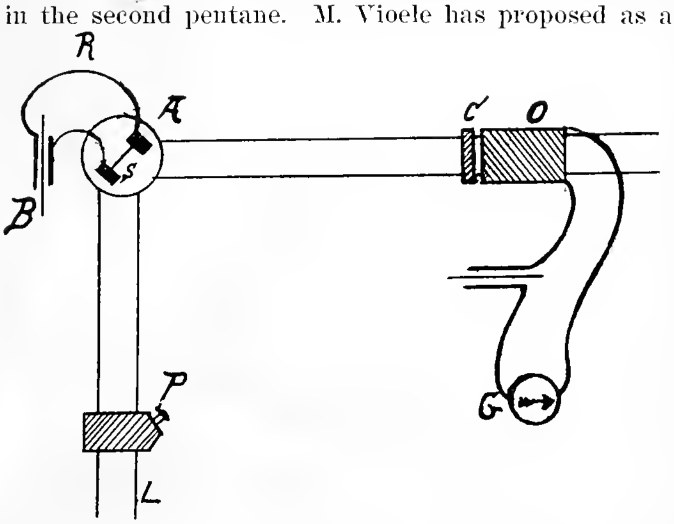


FIGURE 1—Scheme of the Lummer-Brodhum Photometer.

unit the light emitted from a square centimeter of platinum at its temperature of volitization. This, while it would seem to promise good results, has not met with success in the hands of other observers. Another standard proposed independently by Professor S. P. Thompson and Mr. James Swineburn was to use the light given off from one square millimeter of the crater of the positive carbon in the electric arc lamp. None of the standards, however, together with the many more that have been proposed, have fulfilled the conditions required of a practical light unit. At the International Electrical Congress held in Chicago in 1893 attempts were made to bring about the adoption of a unit. Of those considered by the committee the Heffner and pentane lamp were the most promising. Objections were made to the Heffner lamp that the flame was yellow in color, and to the pentane lamp that the commercial pentane is not sufficiently well defined. Finally the objection was made to all open flame lamps that they are too much affected by the temperature, pressure and moisture of the air.

The committee recommended that while its members realized the great progress made by the constructoion of these lamps, yet it was unable to recommend either as a light standard. It further invited all nations to make researches in common on practical, well defined standards, in the hopes of realizing an absolute unit. Since that time some further progress has been made and other forms of units have been proposed. The most of these, however, are mere proposals of what may be a constant source, but lacking careful experiments to recommend them to favor.

The following method of determining a light unit and the one which seems to promise best results so far attained has been used by Professor Lummer and Dr. Kurlbaum of the Physikalisebe Reichsaustalt. As a unit is used the light emitted from a square centimeter of platinum kept at a constant temperature. The platinum strip is heated by an electric current; the temperature is defined by the relation of the amounts of its radations under different conditions. The one is the total radiation of the heated platinum, the other consists of the rays which pass through a definite absorption medium. So long as the ratio of these two remain the same the temperature of the course is constant. The amounts of these radiations are measured by means of the balometer. The principles of this instrument, the use of which has been far reaching in physical investigations, were first worked out by Snanberg and later, but independent of him, by Langley.

The essential part of the instrument consists simply of a high resistance placed in an electric circuit; on this high resistance part of the circuit radiations are allowed to fall and the change in the resistance due to the temperature change measures the intensity of the radiations.

The apparatus used by Drs. Lummer and Kurlbaum consisted of a balometer, with galvanometer and other accessories for indicating changes in resistance, together with the light source, which consisted of a strip of platinum of approximately 25 millimeters wide, 60 milimeters long and 0.015 milimeters thick, so mounted that it formed part of an electric circuit. The platinum was heated to a high temperature by an electric current, whose strength could be regulated by a variable resistance. The light source was mounted on a form of optical bench, with two arms at right angles to each other. Upon the one arm the balometer was mounted, and upon the other a photometer. By rotating the light source, which was at the junction of the two arms, on a vertical axis comparisons could be made either on the balometer for the intensity of the radiations or on the photometer for the light intensity. The photometer used was of the Lummer-Brodhun type; the light with which the standard was compared was an incandescent lamp burning under a current of low intensity.

Previous results show that by burning a lamp in this manner its intensity could be kept constant for a very long period.

The general scheme of the apparatus is shown by Fig. 1. A is a circular plate of marble upon which the platinum strip, S, is mounted. A is so made that it turns about an axis passing through its center. The platinum, S, is connected with copper electrodes, which are connected with the battery, B. R is a variable resistance. In the one arm of the bench is the box, O, which contains the balometer,, which is connected

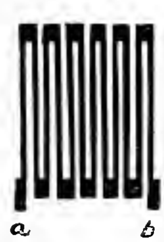


FIGURE 2

on a battery circuit with the galvanometer, G. Between the light source and the balometer is placed the absorption cell, C. This cell is supported on a moveable screen so that it may be carried out of the path of the ray when it is desired to allow the entire radiation to

fall upon the balometer. On the other arm of the bench P and L represent respectively the photometer and the lamp against which the standard was compared.

The balometer was made in the following manner: A platinum plate is placed between two silver plates of some ten times its own thickness; the plates are then passed through rollers, the distance between which is constantly decreasing. As the silver plates become thin they are strengthened by being placed between copper plates and the rolling continued until the platinum is of the required thickness. In this manner a coherent piece of platinum as thin as 1-3,000 millimeters may be obtained. For practical working, however, a thickness of about three times this amount was more satisfactory. The thickness of those used in the experiment was 1-1,200 millimeters. When rolled to this thickness the silver adheres firmly to the platinum and serves as a vehicle for handling it in a manner that would be otherwise impossible. The silver sheet is then mounted on glass with Canada balsam and cut on the dividing engine in the form shown in Fig. 2. The twelve strips are each 1 millimeter wide, 1.25 millometers apart and 3.2 centimeters long. The plate often being cut in this form is mounted on a frame of slate, the extremities being soldered to copper electrodes.

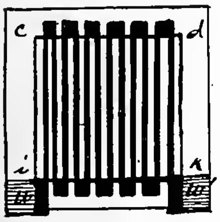


FIGURE 3

Fig. III shows the manner in which the mounting is done; c, d, k, i is the frame of slate, w and w' the copper electrodes to which the extremities of strips are soldered. After the mounting has been done the silver is removed by immersing in nitric acid.

The surface of the platinum is blackened in order that it may absorb all rays received upon it. The blackening was done by means of platin black, thrown down by electrolysis, in a weak solution of platin chloride.

The plate is removed from the glass by chloroform and fastened to the frame by means of resin dissolved in ether. To protect the extremities of the strips from the action of the acid they are covered with Japanese varnish and hyprochloric acid. Two balometers prepared as above described were placed one behind the other so that the strips of one covered the spaces of the other, thus forming a nearly continuous surface on which the radiations were received.

The two pairs of balometers were connected so that they formed the four arms of a Wheatstone bridge. The radiations fell upon the two opposite arms of the bridge.

The balometers mounted in the form for use are shown in Figure 4. The two pairs are mounted in the hard rubber standards, h and h'. The radiations fell upon them in h. The openings, S, allow air to circulate freely through the apparatus. The plate is of copper, blackened so that it will absorb all rays which fall upon it and serves as a screen to protect the balometers mounted in h'.

The absorption cell consisted of a ring of glass with sides formed of parallel quartz plates. The quartz plates were 1 millimeter thick and 2 centimeters distant from each other. The cell was filled with pure water.

The temperature of the glowing platinum was so regulated that the total radiation which fell upon the balometer was to that which passed through the absorption cell in the ratio of 10 to 1.

From a consideration of the curve of the intensity of radiations it is clear that this could be the case only when the temperature of the radiating source remained constant.

The amounts of the radiations were measured by the galvanometer deflections. Since it was impractical to work with deflections one of which was ten times as great as the other, the deflections were made equal. For this three different methods were used. The first was to shunt the galvanometer so that only 1-10 of the current passed through when the total radiations were received.

The second was by changing the resistances of the entire circuit so that their values were in the ratio of 10 to 1 for the total and partial radiations. This method was practical for relative feet, not for absolute measurements.

The third method consisted in changing the distances of the balometer from the radiating source so that the distance for the total radiations was to that of the partial radiation in the ration of the square root of 10 to 1.

At a fixed distance before the glowing platinum a diaphragm of exactly 1 square centimeter area was placed; the light which passed through this diaphragm was taken as the unit.

During the experiments the temperature of all parts of the apparatus, whose temperature change could affect the results, was kept constant by being enclosed in hollow-walled cases through which water was allowed to flow.

In order to reproduce this light unit it is necessary to measure accurately the size of the diaphragm and the thickness of the absorption cell, since these are the sources of error which most affect the results. Another but very small inaccuracy is introduced by a change in the thickness of the black on the balometer. It was found that a change of 50 per cent in the thickness of this black gave a change of 2 per cent in the light unit. This, however, is small when we consider that the process of blacking is based upon conditions

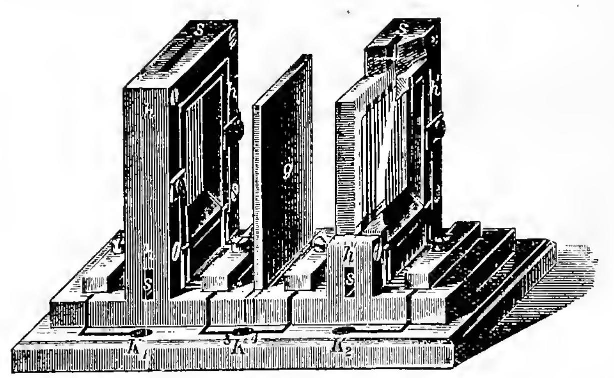


FIGURE 4—A two-pair set of Balometers.

quite readily reproduced, so that the errors in the thickness of the black may be made very small.

A series of observations made with different balometers prepared in the same way gave results, the greatest variations of which were 0.6 per cent.

The above method shows it to be possible to define a light unit in terms of absolute units. It is, however, only a definition and not an expression for the unit in absolute terms. As the term light involves not only the energy of the vibrating particle but the physiological effect upon the retina it is impossible to express a light unit in absolute terms in that manner that we are able to express a unit of work. It is therefore im-

possible to express it in terms of C. G. S. system or at present in any known system, as we know that for lights of different colors, the effect produced is not proportioal to the energy of the vibrations. The difficulty then lies in the comparison of different lights with a standard. It is well known that one of the greatest difficulties in photometric work is the comparison of lights of different colors. The composite thing known as light is, according to the generally accepted theory, made up of the action of a large number of different vibrations. Each vibration produces a different effect upon the eye and the relations of the intensities of the different vibrations determines the nature of the light source. This is shown in the different spectre produced by lights of different nature. We do not know the relative values of different colors in terms of the effect they produce upon the retina. We are then unable to compare the values of the two complex quantities without knowing the relative values of their component parts. In this sense we may say that a light unit is impossible, and so far actual experience has shown it to be true. Attempts have been made to solve the question by using different standards for different colored lights. This would in a way obviate the difficulty, but would give us no standard unit, but different units without a knowledge of their relative values.

Any complete method of comparing two light sources is one that will take account of all colors which are contained in the sources. This implies the valuation of the different colors in terms of their physiological effect in enabling us to see objects about us. A complete unit is one the component parts of which are known so that the above comparisons can be made. We must therefore conclude that in its broadest sense we are very far from a complete solution of the problem of an absolute light unit, and so far that it is not even shown that in its complete sense such a light unit is possible.

Passing Comment

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

THE DEFICIENCIES OF AMERICAN ARC LIGHTING SYSTEMS.

The system of arc lighting used at present in this country is so entirely an American development that we are inclined to neglect the progress which has been made in other countries, and to forget the fact that our methods suffer somewhat from a very early origin of the system, and its exceedingly slow and gradual development. Professor S. P. Thompson has pointed out on more than one occasion that arc lights are more easily run from machinery having a high coefficient of self-induction and has stated that this self-induction of the generating apparatus is more important in an arc lighting system than any possible increase in the efficiency could be and this statement embodies a theory that has been put in practice in all American arc lighting development without regard to the fact that the more recent arc lamps have been so greatly improved and the quality of the arc carbons so much advanced that the force of the argument is much weakened.

As Mr. Alex. Dow has indicated in his articles for December and January in "Electrical Engineering," arc lighting development has proceeded along the lines of larger generating units for the purpose of increasing the engine efficiency without necessarily increasing the efficiency of the electrical generating apparatus. In the March number of this publication Mr. John Hesketh of Blackpool, England, has criticised the American practice from the point of view of an engineer familiar with methods almost unknown in this country, and he has made the very strong objection to our line of progress that the increase in size of steam generating units allowed by the use of 100 light and even 150 light arc machines does not always compensate for the disadvantages of excessive voltage and excessive length of circuits. Mr. Hesketh is an electrical engineer of a station using Ferranti rectifiers, delivering uni-directed constant current from the mains of a constant potential alternating system—a method which allows the employment of efficient generating apparatus, both steam and electrical, and permits the efficient connection of both arc and incandescent systems to the same set of the mains, while limiting the length and potentials of the arc circuits to that necessary for the connection of forty lamps in series.

The Ferranti rectifier, while perhaps not as efficient as the rotary transformer, at the same time is capable of delivering a constant current with a complete transmision efficiency better than can be obtained from the 100 light arc units, when we consider all the losses incident to the employment of small steam units, belt connections, inefficient electrical generating apparatus and lines of excessive length. From Mr. Hesketh's report we are inclined to believe that the Ferranti rectifier may be easily established in substations and the complexity of wire for a large district materially reduced and we are fain to believe that with an increasing appreciation of the losses incident to the installation of small transformers for incandescent lighting, more and more substations will be installed in the larger cities, and that where such substations are used the advantage of short arc lines supplied from current rectifiers will appeal to American engineers as furnishing a more satisfactory method of arc light installation than is to be found in the present tendency toward high potentials and long arc lighting circuits.

THE INFLUENCES OF ATTRACTIVENESS ON STATION ECONOMY.

It is gratifying to notice from an article by Mr. E. T. Adams in the "Engineering Magazine" for March that electrical engineers are beginning to realise the importance of carefully planned surroundings for their generating machinery. Most of the plants described by Mr. Adams have been carefully put up for advertising purpose, though enough instances are given of truly commercial plants carefully planned to indicate a tendency in this direction in central stations. More than ten years ago this subject was discussed before the cotton manufacturers' association of New England and it was at that time believed by them an expenditure amounting to as much as 1 per cent. of the capital stock of the company, was justified in the engine room of a great cotton mill, the principle being held that from the engine room an influence emanated which determined the character of the workmen throughout the plant and the care they were willing to give to the machinery under their charge. In any manufacturing company the employes of the engine room form a sort

of mechanical aristocracy whose methods and habits are copied throughout the entire plant. If the engine room is so fitted up and lighted so that it affords a pleasant living place for those employed there they will take an interest in the proper care of the machinery and personal neatness is fostered with the effect of materially reducing the repair bills not only at this one point but throughout the entire establishment.

As the engine room becomes more important this principle can be carried further and further. A far wider influence extends from the engine and dynamo room of an electric generating station than is possible from the engine room in any manufacturing concern, every workman about the entire plant is employed for some part of his time in the station itself; lamp trimmers are sometimes used in the station as lamp adjusters; linemen construct the station circuits, and so we might go through the whole force of employes and find that at some part of each man's time he is employed about the generating apparatus. If this generating apparatus is accurately installed, if all parts of the system are easily inspected by a superintendent or by visitors, if the tendency towards dinginess is removed from the entire plant, no man will be willing to have his own work pointed out as a disfigurement and the habits of careful and neat workmanship thus engendered will be reflected in his manner of performing his particular spcific duties. At the same time good workmen are systematic opponents of ornateness or inappropriate decoration; carvings and scroll work about a switchboard form an unnecessary item of care in a plant, and while the designer should strive to make the plant as attractive as possible, no detail of accessibility should be in the least sacrificed. Concealed steam pipes and wires do not improve the appearance of an engine room or dynamo room, nor are breakable ornaments to be thought of in such a location, but only neatness and convenience are to be sought after. Colors should be chosen which will show at the same time when they are soiled and be capable of being kept clean with a reasonable amount of care. The artistic effect of fitness in such a place is the only artistic effect that is at all allowable, and when the plant is admirably installed for its purpose, it is at the same time admirably decorated.

TESTING ARC-LIGHTING CIRCUITS.

Mr. Alex Dow has been writing a series of papers upon arc lighting and arc-lighting circuits in "Electrical Engineering," which point to Mr. Dow as a practical engineer with a very clear perception of the practical needs of the business. In the January number the question is taken up not from the standpoint of the possible perfection of the line, but from the far more rational ground of the greatest possible economical efficiency of line. While the tests described do not attempt to apply theoretical principles they do give instructions for ascertaining whether any particular lighting line is in its best possible condition. The absolute insulation resistance tells very little, but the behavior of the insulation during the test may indicate to an experienced engineer the condition of the circuit.

No matter how good the insulation resistance of a submarine line may be it is defective if electrification proceeds irregularly. In the same way Mr. Dow points out that the absolute resistance of an overhead line does not indicate its character as well as its behavior during a storm. Should the insulation fall at first, then rise as the storm proceeds, and rise rapidly when the rain has stopped, the insulation of the line is good, for the rain, in wetting the insulators, has also washed them, but if the wet line falls in insulation and does not immediately rise again we are made aware of a fault which must be located and eliminated. This simple observation shows whether an overhead line is clear or defective and there seems at present to be no other manner of distinctly indicating this condition.

AN UNWARRANTED CONDEMNATION.

One can hardly agree with the universal condemnation of the business methods employed by electrical manufacturing and supply houses expressed in the article on the "Commercial Exploitation of Electricity" by B. E. Greene and published in the Feburary number of the "Engineering Magazine." Electricians can undoubtedly make allowances for Mr. Greene's own attitude of mind in such matters and can see in his article the effects of his long campaign against one particular manufacturing company, but the authority given to his opinons by publication in the "Engineering Magazine" renders them more worthy of attention than has been the case with the publications heretofore.

There appears to be no doubt but that the management of the great manufacturing companies sought for many years to make their money through stock operations rather than in the legitimate channels of manufacturing business, but when the author includes in the condemnation of such business methods the management of all electrical undertakings before the year 1886 he stands self-condemned as misrepresenting facts. Before the year 1885 the secretary of the Bridgeport Brass Company informed the writer that he held stock in almost every New England electric light company and that they were all showing small but constant earnings. Since that time many wildcat schemes have been begun and many failures made, but on the whole the electric light supply and the electric railroad businesses have been supported by sound earnings. The great array of incorporations shown by Mr. Greene for New York State between 1875 and 1895 prove nothing whatever, since in every line of business incorporations are excessive and to pick out the incorporated companies is at once to include all those branches of any business which are at all suspicious. Unreasonable business methods in electrical engineering have brought their own punishment in the past and are daily bringing yet more punishment just as is the case when the real estate values of any town have been boomed. But as costly experimentation has rapidly developed sound engineering in the same way costly financiering has developed a more perfect understanding of the value of electrical properties amongst monied men and has rendered the general tone of electrical business as sound as that of any other industry in the country.

NO USE FOR THE X-RAYS.

Said the maiden, archly smiling:
"Why all this cathodic fuss?
Men should know we've long seen through them,
But they'll never see through us."

— San Francisco Examiner.

THE JOURNAL OF ELECTRICITY.

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EDITED BY

F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

STANDARD WIRING RULES

The convention held in New York for the purpose of drafting a harmonious set of regulations for wiring to be used by the inspectors of electric lighting companies, insurance companies and municipalities should result in two distinct advances in electric installations. In the first place an adoption of the rules which this body shall approve by all of the various authorities who have the right at any time to inspect an installation, should simplify the difficulties attendant upon securing a correct installation of an electric lighting system both for the owner, the engineer and for the electrical contractor, since if these rules are universally accepted the character of the work to be done will be more clearly understood than can be at the present time and there will be less ground for disputes over accidentally and intentionally bad workmanship. At the same time a harmony among inspectors will give more weight to inspections made in any locality and will do away with the present possibility of a piece of work being at the same time accepted by one inspector and condemned by another, with the general result that we will hope to see a more systematic inspection and a more thorough regard paid to rules for installation than is the case at the present time. Inspection now is often a thing to be avoided rather than sought, for the reason that work which has been carefully done and executed in good faith is still likely to be condemned by some one or other of the many inspectors who are all governed by different rules and as a consequence of this condition the owner or engineer depends more upon his own opinion of the method of installation and more upon the honesty of the contractor than he does upon the report of the expert inspector. As a consquence, work is often accepted as satisfactory which would not pass the requirements of any set of rules because the owners are not sufficiently familiar with the dangers incident to unsatisfactory installation. This is true in country districts more often than it is in the cities, although the danger from fire in a country district is often greater than it is in a similar building in a city.

Hardly a house of any pretentions is erected in any country town which is not at the present day wired for the elctric lights even when the future installation of the electric lights is considered only as a possibility depending upon the growth of the town; at the same time these towns do often grow with surprising rapidity and electric lighting is apt to come to meet the growth rather than wait for it. Inspection of such circuits is particularly necessary for the reason that the opportunities for dishonest contractors are multiplied in any such case where expense of installation is the most important item. Such an inspection, however, we can never hope to see until all of those whose opinions are considered as worthy of authority shall unite to choose a set of rules and adopt a common system of inspection.

NOW OR NEVER

In our January number we called the attention of street railway managers to the necessity for combined action in the question of the overhead trolley patent, a warning which derives new emphasis first from a recent decision of the United States Circuit Court granting injunctions against the Billings and Spencer Company and the Kelsey Electric Railway Specialty Company, who have been for some time manufacturing supply parts of the trolley system, and second from the agreement recently reached between the General Electric and Westinghouse Companies regarding patents. The obtaining of these injunctions against two such strong supply firms indicates a disposition to immediately make the most of the recent patent decision and demands some sort of immediate action on the part of electric railway companies in order to forestall still more dangerous movements on the part of the owners of the patents. It is undoubtedly just for the General Electric Company to earn all that it possibly can from the patents which it possesses and it cannot be criticised for obtaining injunctions against those who are infringing in whole or in part, but at the same time we must consider that while the patent will be a very valuable one to it if it obtains the monopoly of the under-running trolley itself, at the present prices for trollies and trolley parts they may, if unopposed, be tempted to not only increase the prices of such machinery beyond that necessary for a reasonable manufacturing profit, but also at the same time attempt to confine the use of the under-running trolley system to roads using only generating and motor apparatus of General Electric or Westinghouse manufacture.

Opposition to such a stand as this on the part of electric railroad managers is a perfectly legitimate operation and the time to contemplate such a position is before the necessary preliminary steps have been taken by the companies named to make such an opposition ineffectual. We can learn something at this time from the history of the incandescent lamp agitation. So long as the able manipulators of the General Electric Company were enabled to disorganize the opposition of the lamp manufacturers and lamp users their legal efforts were attended with an unbroken series of successes in the courts and the lines which they were rapidly drawing round lamp users to compel the exclusive employment of their machinery were only finally destroyed by a combination of three or four lamp companies, which, towards the last, had been reserved for a final attack. The ownership of such vital patents as are now pooled form a powerful commercial weapon and the only shield against it is to be found in a combination of the electric railway people for the purpose of resisting unreasonble demands.

THE USE AND ABUSE OF FUSES

During the past year the question of the relative advantage to be derived from the use of safety fuses and circuit breakers has been so carefully and extensively discussed in the technical journals and before scientific societies that we should expect to be able to find definite information concerning the usefulness of these two methods of protecting circuits stated in a manner so experimentally strong that it will influence the users of these different devices. On examining the stateof theart, however, we find that in spite of this extensive study of the subject no conclusions have been drawn which appeal to all men; and to explain the absences of definite conclusions we must examine the methods used in studying the subject for considered conditions. Immediately upon beginning an examination of the various investigations that have been presented bearing upon this subject we will notice that the usage of fuse wires for protecting electric circuits seems to have been materially changed from the purposes to which they were designed by those proportioning them in the early history of the art. When the fuse wire was originally adopted it was intended to protect the conducting wire of the circuit from being overheated, and at that time it was well understood that the fuse could not be expected to protect the machinery installed upon the circuit; in every instance the fuse was adjusted to the carrying capacity of the wire which it was to protect. All of the recent studies of the fuse wire question have turned upon their ability to protect machinery attached to the conducting circuit, and while in the first case the amount of energy passing over the fuse before its temperature reached the melting point determined its size; in the more recent investigations of the fuses the criterion of quality has been assumd to be the value of the current necessary to melt the fuse. Why the extensive experiments that have been performed on the basis of this second hypothesis should have been necessary is an exceedingly difficult question to answer for the reason that any one examining the conditions necessary for raising a given piece of metal to its melting point by the means of the passage of an electric current will at once find that the melting point is a time function of the energy, and in consequence cannot be stated in terms of current. Nothing further than a confirmation of this theoretical deduction has been derived from the experiments performed.

Now let us consider what is the true function of the fuse wire and to what tests fuses should be subjected in order that we may ascertain their value as a means of protection in any electric circuit. The fuse wire is composed of a conducting material just as the circuit itself is composed of conducting material. When a current is sent over the circuit it heats both the fuse wire and the conductor, the amount of heat thus produced being a function of the time and the ultimate temperature of the conducting metal in both cases depending upon the total amount of heat generated and radiated in the given time. Should a greater amount of current be passed both the fuse and the conducting circuit which is to protect are heated more rapidly and attain the given temperature in a shorter space of time. If this given temperature is the melting point of the fuse then at the time the fuse was melted the circuit had attained a certain specified temperature, and that it did not exceed this temperature,whether the fuse was melted slowly with a small current or quickly with a great current. If the safety fuse is tested by a determination of the temperature of the wire it is proposed to protect, the device has been subjected to a proper and rational test, but if the safety fuse is tested by an attempted determination of the amount of current necessary to melt it, we can see from theoretical considerations that the experiment will be inconclusive and that the current necessary for melting the fuse be a function of the time. The fuse, therefore, is an instrument admirably adapted to the protection of a wire circuit against overheating, but is entirely unsuited for the protection of apparatus against excessive current flow. As soon as experimentors will acknowledge these principles and obtain results in accordance with them we shall begin to have a clear understanding upon the subject of safety fuses and approach a basis upon which they may be satisfactorily be chosen.

ACCURATE PHOTOMETRIC MEASUREMENTS

We are presenting in another column a review of the most recent progress in the efforts to obtain a satisfactory standard for the measurement of light. For the benefit of those who make use of any standard in the measurement of candle powers we think it wise to point out more spe-

cifically some of the difficulties encountered in making these measurements. The search for a standard is important not so much on account of the fact that the standard which any experimenter may use for candle power measurements is liable to variation as on account of the fact that the same standard constructed at different times and by different experimenters may vary in value, as for example, Methven screens which are capable of concordant results under any particular set of conditions. Irregularities in measurements made in any particular laboratory are more often due to the construction of the photometer itself or to the personal equation of the eyes of different expermenters using the photometer than to variations in the standard employed. Candle power measurements are important to the central station manager, not so much on account of their absolute accuracy when compared with measurements made in other laboratories as on account of the comparative accuracy obtained in different measurements of lamps to be tested which are performed in the one central station laboratory. If the measurements made at different times upon different lamps give a true comparison of their relative candle powers the central station manager has at his command all the facts necessary for the choice between lamps.

Such comparative measurements can be made if care is taken to use a fairly satisfactory standard installed in a photometer where there are no reflections and operated by one careful observer who is working under conditions which allow him to be undisturbed in his measurements. Such a photometer is best obtained by installing the lights to be measured in an open dark room ithout a special photometer box, taking care only that direct light shall never fall upon the eye of the operator; the adjustments of flames and lamps being performed by an assistant. This dark room must be free from noise, from vibration and must be supplied with pure air since all of these things are experimentally proven to produce inaccuracy. The ordinary portable photometers which are sold by instrument makers are especially inaccurate mainly on account of the fact that they have serious internal reflections and allow the eye of the operator to be continually subjected to daylight. However convenient it may be to carry a photometer from place to place to examine lights upon the particular circuits where they are running, such observations can only be considered as the roughest sort of approximations to the true results and not at all comparable in accuracy to measurements made at the same voltages in a well installed dark-room photometer.

The installation of an accurate photometer is an important matter in central station equipment since it enables the closest sort of buying of high efficiency lamps while at the same time its inaccurate installation will be a continual source of annoyance.

THE PATENT SITUATION

It was announced on March 12th that final arrangements had been effected between the Westinghouse and General Electric Companies for a common exploitation of their many patents and the future avoidance of useless and expensive patent litigation. Such an arrangement naturally calls to mind a similar agreement between the Edison and Thomson-Houston Companies which finally resulted in the consolidation which brought forth the General Electric Company, and we naturally enquire whether this agreement does not precede a still more gigantic consolidation. A few years ago such a consolidation, would have meant an electrical trust controlling the entire electrical manufacturing business of the United States, but at the present time these two companies represent a monopoly of the old unbusinesslike methods of electrical exploitation rather than any more dangerous monopoly. Without show, without blast of trumpets, without the exploitation of stock, the Siemens and Halske Electric Company, the Stanley Electric & Manufacturing Company together with the Walker Company have firmly established great houses administered according to business principles and they have for the past three or four years been able to secure some of the most highly coveted contracts let during that period; all this without mentioning the achievements of the strong Fort Wayne Electric Corporation and the numberless smaller manufacturing companies. We can easily see that these three first mentioned houses have eliminated from the electrical business during the past few years many of its most objectionable features and that they have rendered almost impotent even before it was accomplished this most recent great consolidation.

The patent contests that have been carried on during the past twenty years have so often been for mutual benefit rather than ith any idea of the success of one side that the patents have been deprived of much of their power. We may not conclude that the litigation that has disgraced the business in the past will now be carried on against the smaller concerns for many of these patents, so much fought over, had no true original basis beyond the necessity of obtaining a cause for contention in the courts and the very existence of the litigation between the great owners of the patents has been the bugbear which has hindered healthy extension in electrical manufacture rather than the existence of the patents themselves. In some minor cases these companies may own patents which will now be respected as they have not been respected before, but we believe in the main the discontinuance of patent litigation means an acknowledgement of its uselessness, rather than a decision to begin it anew against new competitors, and we should read in the consolidation an understanding of the necessity for strictly business methods to be employed in obtaining future business, a healthy conclusion which has been compelled by the success of honest business houses in the electrical field.

Hydraulics

AN EXPERIENCE IN FLUME CONSTRUCTION.

The rapid development of transmission projects in the West and the frequent occurrence of obstacles that are generally unforseen by all but capable engineers, renders any unusual experience in the development of water power or transmission plants of value, and as a result the peculiar experience of the Kings River Lumber Company in its attempt to carry a water flume across a suspension bridge over the Kings River in Fresno County, California, is of interest. bridge is 451 feet in length between the towers and is supported by seven $1\frac{3}{8}$-inch steel cables of Roebling manufacture on each side. The bridge has a grade of nearly 1 per cent, and although the Pacific Bridge Company maintained that the flume could not be operated across the bridge successfully without a stiffening truss, the owners, acting upon their own responsibility and in order to reduce the cost of construction, built the flume without stiffening trusses, as shown in Figure 1. The structure appeared in perfect condition before water was turned into the flume, the grade being gradual and the flume having every appearance of being a perfect piece of workmanship, but when the water was let in results ensued which were quite unexpected to the owners, although clearly foreseen by the engineers of the bridge company. When the water was let in at the head it caused a slight de-

FIGURE 1—AN EXPERIENCE IN FLUME CONSTRUCTION.

As shown in the accompanying illustrations this flume is of V-shaped section, is fifty-two miles in length and at some places has a grade of nearly 23 per cent for about 1,000 yards, giving a total fall of nearly 750 feet. In this connection it is somewhat surprising to learn that in addition to transporting lumber the flume carries passengers and freight in a boat that is a V-shaped box about sixteen feet long and which is roughly knocked together with boards, since it is "good for one trip only." The front end is left off as the velocity of the water is such that it will not run back into the boat. A plank is placed along the bottom, on which the passengers rest their feet while sitting single file on cross seats. When all is ready the spikes by which the boat is held while loading are pulled out and away it goes on its fifty-two-miles journey, in some cases attaining the terrific velocity of seventy or more miles per hour.

The feature of particular interest at present in the construction of the flume, however, as described by Mr. F. A. Koetitz, of the Pacific Bridge Company, rests in a curious experiment tried during the erection of the suspension bridge previously referred to. This flection in the first half of the bridge raising the other half. This deflection of course caused a rapid increase of water at the point of greatest deflection on account of the shape of the flume until the water banked up sufficiently to overflow, as shown in the illustration. This overflow, however, prevented any further deflection, but instead, a reaction set in, the point of overflow would run slowly over the center, loading the other half of the bridge, thus having a tendency toward equalization of the load, but the momentum of the water would soon over-balance the load, when the first half of the bridge would raise a little, assisted by its reaction, the second half would deflect accordingly; the water would commence to run faster over the center; the area of water would increase rapidly at the lower half and would deflect and act in the same manner as the first half had done with a resultant overflow. This process would be repeated with a continuous wave motion from one end of the bridge to the other, the time of the oscillatory motion for the "round trip" being one minute and forty seconds, and the action would continue ceaselessly until the water was turned off at the head, when, after it had run or

leaked out, the bridge would come back to its normal position.

It is perhaps needless to mention that the owners turned to the Bridge Company for a solution of the difficulty, when a stiffening truss, as shown in Figure 2, was put in, after which not the slightest trouble was experienced, even under heavy concentrated loads, such as those produced when a "boat" crosses the bridge, damming up the water behind it and lowering the water for some distance in front.

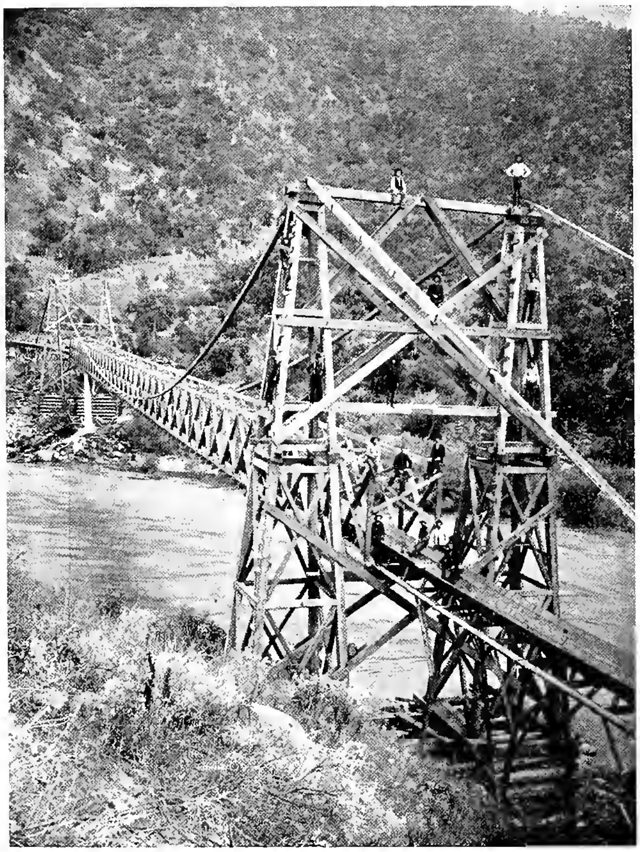


FIGURE 2—AN EXPERIENCE IN FLUME CONSTRUCTION.

The Trade.

PROTECTION AGAINST LIGHTNING.

There are few problems in electrical engineering which have presented so many difficulties and at the same time been so successfully solved as that of protecting electrical apparatus against lightning. The skillfully conducted and persistent researches of Mr. A. J. Wurts, of the Westinghouse Electric and Manufacturing Company, in connection with this problem, his discovery of "non-arcing" metals, his successful construction of Non-Arcing Lightning Arresters and the final award to him, by the Franklin Institute of the John Scott Legacy Premium and Medal, are so well known throughout the electrical world as to leave little room for more than a reiteration of the facts concerning the now perfected methods of protection against lightning.

The Non-Arcing Lightning Arresters could not be better described than in the simple and comprehensive language found in the report of the Franklin Institute, from which it is plain that with but few exceptions all

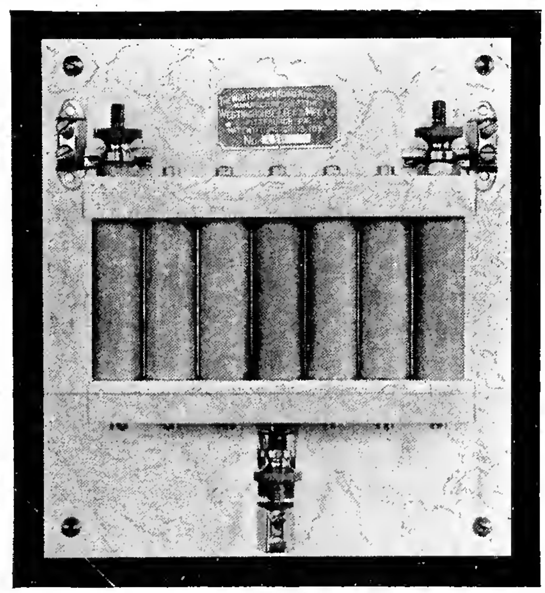


FIGURE 1—Protection Against Lightning.

lightning arresters commonly used, up to the inventions of Mr. Wurts, have been based upon the fact that static discharges generally tend to "ground" by the shortest distance—even when obliged, in order to do this, to jump a considerable "air-gap"—in preference to taking a longer path over a much lower resistance. An arrester of this kind, while often affording a release from the static charge, would also allow the dynamo current to follow upon the arc so produced, thus producing either short circuit or a dangerous "ground," and in both cases causing an interruption of the main working circuit. Hence, the more improved arresters of this type were so constructed as to break

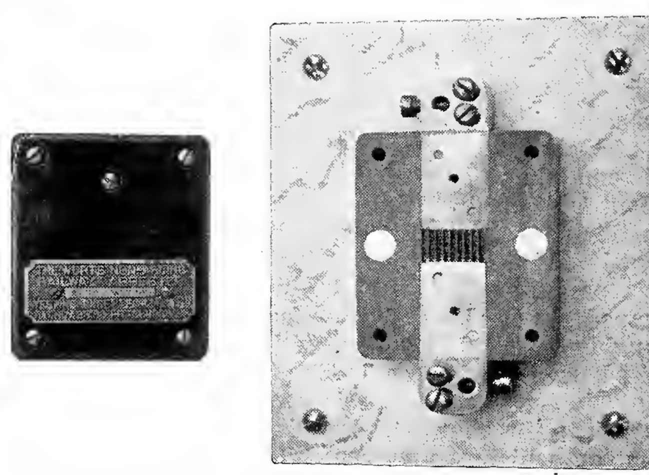


FIGURE 3—Protection Against Lightning.

the dynamo arc as soon as possible. This is easily seen to be a remedy rather than a preventive.

Mr. Wurts perceived this fact and as a result constructed an arrester in which the dynamo arc could not start, rather than one which would break the arc when started, and the "Non-Arcing" Metal Lighting Arrester (Figure 1), although the simplest in construction, is, perhaps, the most notable of all Mr.

Wurts' arresters. It consists simply of seven cylinders of metal, each one inch in diameter, and three inches long, mounted side by side, and separated from one another by one-sixty-fourth of an inch. The central cylinder is joined to ground, and the two outside ones to the two legs of a 1,000-volt circuit. They are knurled on their surfaces, and fixed so that they can individually be rotated upon their axes. When a static discharge takes place, either from one side to ground or from both sides simultaneously, it is found that the flash is instantaneous, and is not followed by an arc, while the temporary change in current value in the main circuit is too small to be easily appreciable. After-examination of the cylinders exhibits a slight black pit or burn where the discharge has passed, and it has been found that this non-arcing property is confined to certain particular metals and combinations of these metals. The most common are zinc and antimony, with which it is impossible to start and continue an arc when they are separated by an air-gap of about one-sixty-fourth of an inch. With longer gaps, e. g., half an inch, vicious arcing is said to occur —a most peculiar fact. Various explanations are offered to account for this non-arcing property, the one most generally adopted being that the metals immediately produce a non-conducting oxide vapor, over which the current cannot pass.

The non-arcing arrester just described is not suitable for any but alternating circuits. For electric railway circuits a different arrester, as shown in Figure 2, has therefore been devised. This consists essentially of a spark-gap, joined by a non-inductive high resistance, made of charred wood. A cover is then placed on the arrangement, and acts as a suppressor of any conducting vapor which might tend to be produced upon discharges taking place. The high resistance, or more properly, the conducting film between the electrodes, seems to act as a wedge through the dielectric, and over which discharges pass disruptively to earth, making a sharp sound, similar to the crack of a teamster's whip. An arrester of this type submitted to the committee of the Franklin Institute, and said to have been struck several hundred times, has suffered but littl damage.

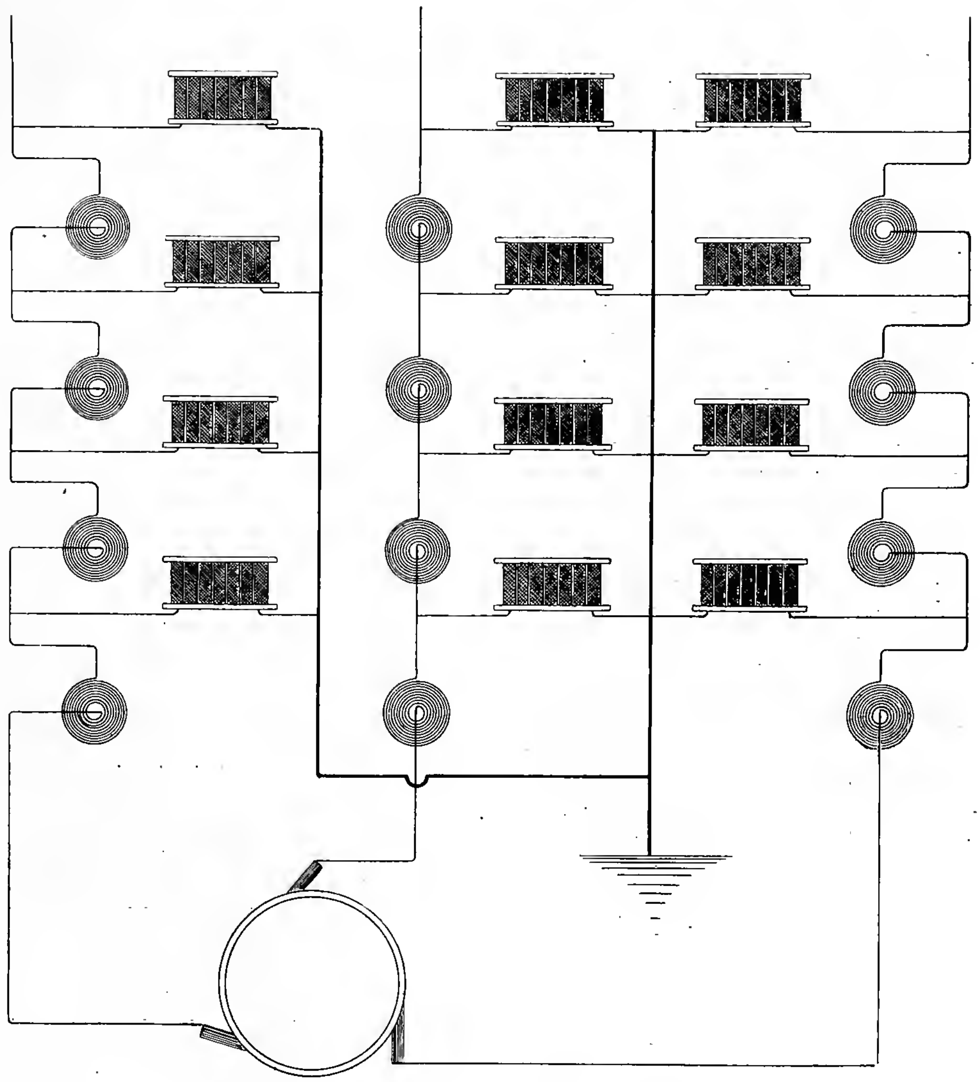


FIGURE 3—PROTECTION AGAINST LIGHTNING.

A lightning arrester connected in the neighborhood of a motor or generator does not necessarily protect that apparatus. If the insulation of the appartus be weak or defective, the apparatus is quite as likely to protect the lightning arrester as the lightning arrester is to protect the apparatus. If the lightning arrester is to protect, the insulation must be sound and of a definite strength.

And yet with even the best of insulation a lightning arrester does not always protect. The reason for this is

not obvious. That which we see and call a lightning flash is not a simple passage from a cloud to the earth; it is a vibration. The lightning oscillates back and forth. The oscillatory character of lightning and of disruptive discharges in general, gives rise to complicated phenomena. Electric oscillations, or waves, interfere with one another much as water waves do. If a trough of water be raised at one end and then quickly lowered, the water in the trough will quietly surge back and forth. If the end of the trough be raised a second time a new system of surging may be started in such a manner that the two will interefere with each other and cause splashing at certain points where crests of the two systems combine to form higher crests. Calm or smooth surfaces will be noticed at points where the crest of one system has been neutralized by a trough of the other system.

In electric wires we have somewhat analagous conditions during thunder storms; we have what a sailor would call a choppy sea. The calm places and splashing places are very close together, so that (and now we come to the point we are looking for) a lightning arrester, for aught we know, may be connected at a calm place, or at a splashing place. If at the former, no discharge will take place at the arrester and the apparatus is liable to become damaged. If at the latter, however, a discharge will take pace and the apparatus will be protected. But these splashing places are constantly shifting their positions. How, then, is a lightning arrester to be properly located? Answer—By connecting such a number of lightning arresters along the line that several of them are likely to be found at splashing places. Possibly arresters which are at splashing places on one occasion may or may not be found at such places on some other occasion. The number of arresters should, therefore, be such that for all conditions some of them, at least, will be found at splashing places.

The successful operation of lighting arresters depends upon a systematic arrangement of the lightning arresters, or a combination of lightning arresters and choke coils, and upon the care with which the installation is made with reference to short straight ground wires, reliable earth connection and maintenance of these connections.

The protection of electric light and power circuits divides itself under two heads: first, the protection of distributing systems; second, the protection of transmission systems.

The protection of distributing systems is effected by means of lightning arresters distributed at frequent intervals over the system. In suburban and otherwise exposed districts four to the mile of wire are recommended. In city districts two are usually found sufficient. For railway systems ground connection to the rail is preferred.

Power transmission systems do not require line arresters. The points of protection being at the extremities of the system, namely, in the power house and motor stations, a bank of lightning arresters, in combination with choke coils, is installed at each of these points. Such a bank is diagramatically illustrated in Figure 3, which represents one end of a three-wire system. For voltages up to 3,000 volts, four choke coils arranged in series in each wire, with lightning arresters intervening, are recommended. For higher voltages than this special combinations have to be made, according to the general characteristics of the system with reference to the capacity of the generator and the use of raising and lowering transformers.

An installation of this nature is preferably made in a small lightning arrester house, built for the purpose and located with special reference to the location of a ground plate in permanently damp earth. The ground plate is preferably made of tinned copper sheeting, and when buried should be provided, both above and below, with a two-foot layer of crushed coke or charcoal.

Although the season has scarcely opened, the demand for Wurts' Lightning Arresters that is being made on the Westinghouse Electric and Manufacturing Co. bids fair to phenomenal. How popular this lighning arrester has become, and how well it has proved its efficiency, may be gathered from the fact that during 1894 the Westinghouse Company sold nine thousand arresters, and in 1895, twelve thousand, while every indication for the present year promises to double the sales of last year.

NEW RAILWAY SUPPLY AGENCIES.

In view of the fact that Abner Doble Co. is now installing some of the largest railway generators on the Pacific coast, it was with considerable satisfaction that the following communication was received from the Detroit Railway Co., concerning four multi-polar direct connected generators, two being 400 kw., and two of 800 kw., and all being built by the Walker Manufacturing Co. After stating that the company is more than pleased with the results obtained from these machines, the letter continues: "Early in the winter when we were extremely short of power, and had but the 2-400 kw. machines available, on several occasions we ran these machines for upwards of ten hours with a 50 per cent. overload, with absolutely no sparking or other injurious effects. On one occasion we carried 1400 amperes at 550 volts on each of these machines for four hours. We have not as yet had occasion to overload the large machines to this extent, but we have every reason to believe from their present operating that they would act equally as well under similar circumstances.

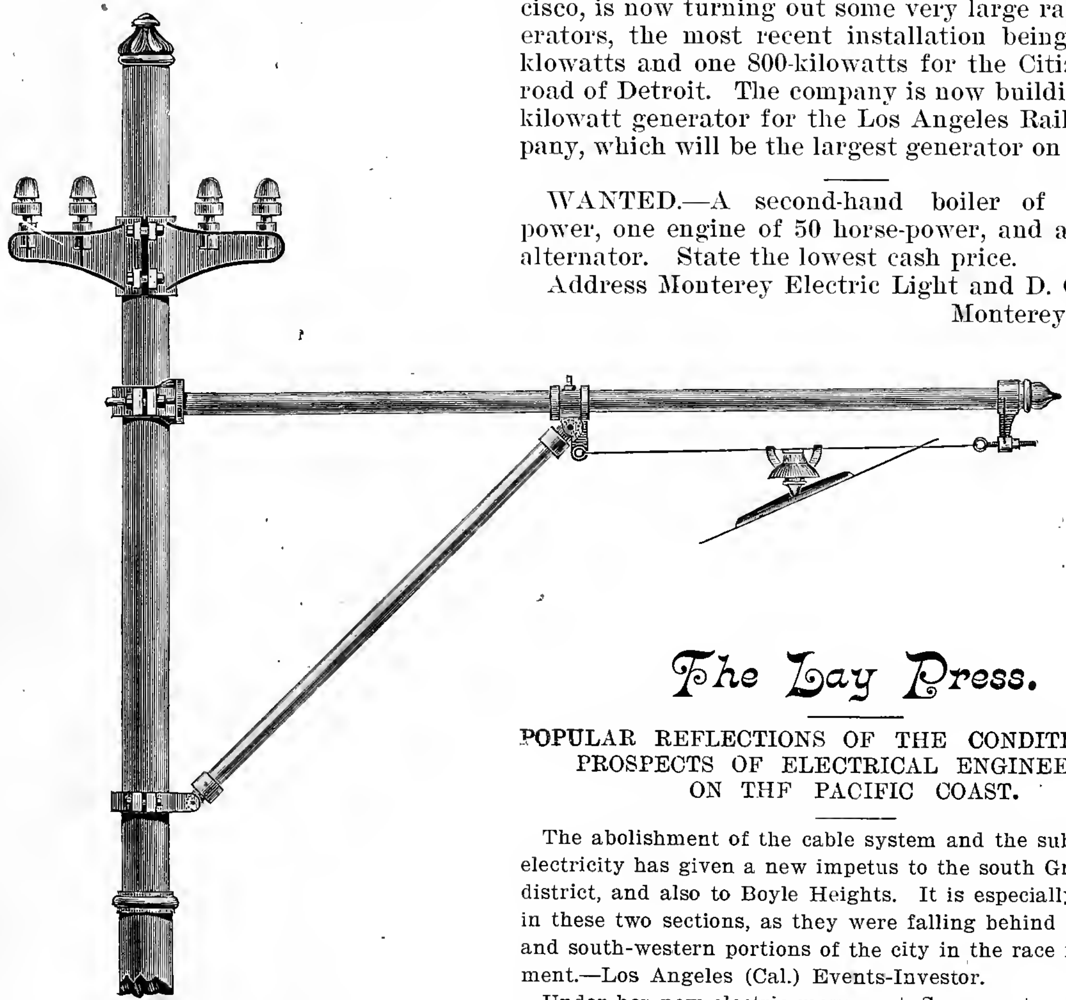
"These four generators have now been running upwards of two months without the removing of a single brush and with absolutely no repairs to the commutator or other parts, with the exception of ordinary cleaning. With a full load on these machines are absolutely sparkless, and the fact of our placing with you an order for two more of the 800 kw. generators is sufficient proof that we are thoroughly satisfied with your apparatus. Owing to the liberal brush contact on commutator one unusual result is obtained, namely, that the commutator is the coolest of any of the working parts of the machine after a long and heavy run."

Messrs. J. W. Brooks & Co. are finding a most gratifying demand for the flexible conduit made by the American Circular Loom Company, for which they are sole Western agents. Contractors and constructors are beginning to appreciate the ease with which it is run, as there is no necessity for joints, elbows, etc., because it may be run an entire length and its tightness is not dependant on the nicety of the fittings of a number of joints, or the carefulness of the constructor.

The firm is also carrying a full line of all material

necessary for bell and annunciator work, and are finding a ready demand for the same. Their Iron Box Bell is meeting with favor beyond all expectation.

An evidence establishing the fact that Eastern concerns of prominence are beginning to realize the promising field which the Pacific coast offers to those who will avail themselves of it, is found in the large number of well-established Eastern concerns which have of late secured branch office establishing Pacific coast agencies in San Francisco. Among these concerns may be named the old reliable house of Morris, Tasker & Co., which was established in 1821 in Philadelphia, and which has since that time built up an enormous business in the line of iron founders, gas engineers and machinists. Its mills are at Newcastle, Delaware and Philadelphia, and the general superiorits of its wrought iron pipe and fittings has resulted in enabling the concern to bring out a recent line of electric railway equipments of a quality surpassed by none. This house has selected as its Pacific coast agency, the Abner Doble Co., itself an old concern, having been established in 1859, and which is now prepared to deliver Morris-Tasker materials in any quantity on short notice. Among these materials may be mentioned iron pipe and wood poles, flexible pipe brackets and all regular standard overhead material. These brackets are peculiarly original in that they support a span wire, hitherto accomplished only in the ordinary standard pole construction and which thus gives in bracket construction all the flexibility of double pole construction. In addition to these brackets, which are adjustable, Morris, Tasker & Co. are the makers of the Philadelphia Standard Trolley Pole, the heaviest of which will safely carry a span wire strain of 7000 pounds. Special attention is also given to iron and steel poles for telephone, telegraph, electric light and power uses.



MORRIS & TASKER BRACKET CONSTRUCTION.

The Walker Manufacturing Company, which has recently placed its Pacific Coast business under the management of the Abner Doble Company of San Francisco, is now turning out some very large railway generators, the most recent installation being two 400-klowatts and one 800-kilowatts for the Citizens' Railroad of Detroit. The company is now building an 800-kilowatt generator for the Los Angeles Railway Company, which will be the largest generator on the Coast.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

The abolishment of the cable system and the substitution of electricity has given a new impetus to the south Grand avenue district, and also to Boyle Heights. It is especially noticeable in these two sections, as they were falling behind the western and south-western portions of the city in the race for development.—Los Angeles (Cal.) Events-Investor.

Under her new electric movement, Sacramento will soon become something more than the city of the Capitol, and develop a civic life in which the Capitol will be only a sideshow—San Francisco Call.

Unless all signs fail the growth of Santa Rosa is to be marked in the next twelve months. There is a large area of fertile country extending in all directions from the county seat, the population of which must ever look to this city as its base of supply, wholesale distribution point and chief market for the product of orchard and farm. Business men see plainly that as rapid suburban transit; there will also be a steady growth of manufacturing enterprises requiring cheap motive power. In whatever aspect the problem is viewed, it becomes apparent that the proposed scheme of cheap motive power is the key to success. We are only on the threshold of the development of electrical energy generated by water power, and Big Sulphur creek, which runs from behind the Mayacmas range of mountains into the Russian river at Cloverdale, has a fall and volume sufficient to furnish all the power necessary to supply Santa Rosa and intermediate cities with all the electric light and power they may need. Capital will here find a good opening for profitable investment, and we are informed that certain capitalists in Oakland are already looking into this matter with a view to development along this line.—Santa Rosa (Cal.) Democrat.

This is certainly the age of electricity for light, heat and power. From all directions comes the news of the diversion of water falls for the purpose of furnishing the power for electric appliances for dynamos. The power thus generated can easily be transmitted by wire to a great distance at a loss of only one-half of one per cent per mile. Sacramento operates its electric cars, and is furnished with power for other purposes, from the water flowing over the dam across the American river at Folsom. Fresno is installing a system over thirty miles from that city. Mariposa county is installing a plant for the purpose of running the extensive mining machinery in that county. This county alone seems to be backward in taking advantage of the opportunities offered. The water flowing over the dam at La Grange has been estimated, by competent authorities, to be sufficient to furnish from 5,000 to 8,000 horse power. This amount of power would be sufficient to turn every wheel in this valley from Fresno to Stockton. * * * Those towns located near mountain streams all along the foothill districts, could no doubt make use of the streams falling down the mountain sides to produce electric power adequate to all their needs at much less cost than is now required for but a small part of the conveniences which cheap electric power makes possible. There is a wide field in the development of cheap electric power by means of the water wheel, and the distribution of it at small cost to the people of neighboring cities, towns, villages and farms.—Modesto (Cal.) News.

The entire talent of Bernal Heights was recently invited to an entertainment given in honor of the coming of age of Terrence Flannigan's daughter. Nothing was left undone that could be devised to make every one feel at home and happy. The Misses McManus, who have more than a locality reputation as vocalists, were present, but the star of the evening was Professor McNally, who had been making some experiments with the cathode ray. The Professor had brought his apparatus with him and a feast of reason was anticipated.

Phil. Burns' billy goat was tethered in the back yard, and occasionally the horns could be heard as it tried to pry clapboards off the back of the house.

About 11 o'clock Mr. Terrence Flannigan called for attention and announced that Professor McNally would now give an exhibition connected with his latest discoveries in the field of science. Mr. Philly Burns had consented that some experiments should be tried with his goat.

The announcement caused a hum of general approval, and after a few preliminaries the goat was led in. In order to keep the animal quiet, Professor McNally said it would be nec... y to administer an anesthetic. This was done and the g... became at once a fit subject for investigation.

It is not in the memory of man that a social gathering at Bernal Heights was ever so electrified before.

"'Fore heaven," said McNally, as the interior of the goat began to be revealed.

"Mother of Moses," murmured Miss Flannigan.

Distributed throughout the goat's anatomy were a watch and chain, a tooth brush, a razor, half opened, a corkscrew, a child's shoe, one undigested raw turnip, a small pewter mug, a soft rubber ball and a wooden peg.

"Get out a search warrant," demanded Mr. Casey, who had lost the watch and chain.

"Dissect the craythur," lisped Miss McManus.

Mr. Philly Burns pushed the crowd aside and took up the goat to carry it out. A small roit took place, and when it was over the goat was found to be dead. Mr. Philly Burns now threatens a suit for damages against Professor McNally for killing the goat with anesthetics, buh McNally smiles skeptically and says that the articles revealed by his Roentgen ray experiments were enough to have caused Billy's death eventually. Mr. Flannigan is blamed for turning a coming-of-age party into a scientific expose. In fact, the chilliness caused by the affair has settled like a frost over Bernal Heights.—San Francisco Examiner.

Personal

Mr. C. P. Gilbert, Manager of the Detroit Edison Company, is as usual "summering" the winter in California, and is at present in San Francisco.

Mr. J. W. Godfrey, known the country over as "Genial Jim, of Habishaw wire fame," is again on the Coast, and is at present at the Palace Hotel, San Francisco.

Mr. J. C. Pierson, for many years Superintendent of the Capital Gas Company of Sacramento, has resigned, and Mr. George W. Jackson has been promoted to the vacancy.

Mr. John Martin, Pacific Coast agent of the Stanley Electric Manufacturing Company, and who has been East for the past month, is expected to return about Aphil 15th.

Mr. J. F. Gray, Secretary of the Mechanical and Electrical Departments of the late World's Columbian Exposition, and more recently of the Atlanta Exposition, is touring California.

Mr. E. C. Sharp, Consulting Engineer for the cities of Riverside and Colton, has been in San Francisco for a fortnight on business connected with the municipal transmission and lighting plant of Riverside.

Mr. George Bole, Manager of the Pittsburg office of the Babcock & Wilcox Company, is in San Francisco, and will visit various points of interest on the Coast in quest of rest and recreation.

Mr. L. B. Pemberton, of late associated with the Fort Wayne Electric Corporation, has assumed the Southern California agency of the General Electric Company, with offices at 225 West Second street, Los Angeles.

Mr. John A. Britton, Secretary of the Oakland (Cal.) Gas, Light & Heat Company, is now in the East, presumably for the purpose of looking up machinery for the rebuilding of the Berkeley Electric Light Company, in which he is heavily interested.

Mr. E. E. Stark, of the electrical engineering staff of the Stanley Electric Manufacturing Company, has completed the installation of the power transmission plant of the Nevada County Electric Power Company, and is at present in San Francisco with headquarters at the offices of the Stanley Company at 106 Market street.

Mr. W. J. Barrett, Los Angeles representative of the John A. Roebling's Sons Company, was among the recent visitors of San Francisco. Mr. Barrett is one of the "Committee of Thirty" of the coming Fiesta in the Southern metropolis, and was warm in his assurances that those of the electrical fraternity who attend the carnival will find him to be "the bureau of information for Southern California."

Obituary

William F. Atwater, late senior member of the pioneer independent railway supply house of Reger & Atwater, died in San Francisco on March 30th, after a brief illness, of typhoid-pneumonia. Having the fortunate faculty of blending geniality and business shrewdness most agreeably, it was mainly through his efforts that the firm won a wide popularity, which can hardly be otherwise than enduring. It is announced by the executors of the estate that Mr. Atwater's interest in the business will still be maintained, and that both the firm name and its location will remain unchanged.

It is with deep regret that announcement is made of the death of Mr. Nat. W. Pratt, at his home in Brooklyn, N. Y., on March 10th, and in his demise the mechanical engineering world, while losing one of its shining lights, revers the memory of his genius to which is largely due the development of

the Babcock & Wilcox boiler. Indeed, the world-wide fame of this appliance is his best monument. Born of stanch old New England families, which settled in Plymouth county, Mass., in 1630, he inherited mechanical tastes from his father, William Pratt, who was Superintendent of the Burnside Armories at Providence, R. I.; during the war, and to the energy, engineering ability and remarkable business qualifications of the son is alone due his rising from humble beginnings to the presidency of the great Babcock & Wilcox Company. Mr. Pratt was noted not only for his sound business judgment and remarkable energy, but also for his generosity and kindness of heart. Even his business opponents admired him for his singular aggressiveness as applied to business, and by all with whom he came in contact, both at home and in trade, he was universally loved and admired.

Reports of the Month.

LITIGATION.

San Leandro, Cal.—Judge Ogden of the Superior Court has overruled the demurrer of the city of San Leandro in the action brought by J. A. Hammond to prevent the sale of the $10,000 electric light bond issue.

Santa Cruz, Cal.—Owing to the purchase of the stock of the plaintiffs ,the various suits of F. W. Swanton et. al., against the Electric Light & Power Company, have been dismissed, with one exception, viz.: that of Swanton to recover $12,000 alleged to be due.

Tacoma, Wash.—The suit of the Tacoma Railway & Motor Company and P. D. Armour Jr. and J. O. Armour, of Chicago, against the New York Guaranty and Indemnity Company, Trustees, and which will soon come to trial in the Federal Court here, promises to be very sensational. It is averred that the late Paul Schultz fraudulently transferred stock and bonds of the Tacoma Railway & Motor Company to the amount of $746,000 to the General Electric Company, the Northwest Thomson-Houston Electric Company and kindred companies, which amount was in excess of the value received by the Tacoma Company for electrical apparatus and other equipment.

TRANSPORTATION.

Lompoc, Cal.—George H. Long is advocating an electric road.

Gastroville, Cal.—An electric railroad from the depot at Moss Landing is being discussed.

Stockton, Cal.—An electric launch will make its appearance on the Stockton channel and lakes this summer.

Pomona, Cal.—The Orange Grove Street Railroad Company, in a communication presented to the City Trustees, stated it is figuring on operating a line of storage battery cars.

Tucson, Ariz.—C. F. Hoff's application for an electric railway franchise has been granted upon condition that the work be begun within 90 days, and be finished to the University within one year.

Sonora, Cal.—Colonel N. W. Griswold of Kenwood is authority for the statement that an electric road will be built from Santa Rosa to Sonoma and, when completed, will carry passengers at the low rate of 1 cent a mile.

Mill Valley, Cal.—The grading of the roadbed for the Mount Tamalpais Scenic Railway is being vigorously prosecuted, and contracts have been awarded to the Risdon Iron Works for engines and boilers. "G. E. 1200" equipments are to be used.

San Bernardino, Cal.—W. B. Taylor, of Toledo, O., is at the head of a syndicate that is contemplating the purchase of the Kansas City tract, and if this is done an electric road will be built, making a circuit of the valley within the Santa Fe loop.

Fortuna, Cal.—F. Nelson, proprietor of the electric light works of Ferndale, states that an electric railroad will be built this summer between Fort Kenyon and Fortuna by himself and four San Francisco associates, provided the necessary franchises and rights-of-way can be secured.

City of Mexico, Mexico.—H. C. Butler, representing an English syndicate, has purchased the street-car systems of the entire city, the price paid being reputed to be about $7,500,000. The new company has already taken charge of the system, and it is stated will spend $12,500,000 more in equipping the system with electricity and making many other needed improvements.

Sacramento, Cal.—L. T. Hatfield, President of the Sacramento, Fair Oaks and Orange Vale Railway, has issued an open letter to the public to the effect that local indifference would cause an abandonment of the project, whereupon a citizens' committee was appointed to canvass the city for subscriptions, and there is every reason to believe now that Sacramento will subscribe to one-quarter of the bonds as required.

San Diego, Cal.—The endeavor to sell the San Diego cable road at its appraised valuation, $121,500, failed, and that figure was reduced by the auctioneer until $55,000 was reached, below which he would not go. It is stated that, since then, five citizens of this place have agreed to take four-fifths of the road at $45,000, the owner, George B. Kerper, retaining one-fifth, for the purpose of converting it into an electric line at once.

Belvedere, Cal.—It is stated that the Belvedere Land & Water Company will build an electric railway from San Rafael to this place to be operated in conjunction with a ferry to San Francisco. This action is believed to be determined upon should the consolidation between the North Pacific Coast Railroad Company and the San Francisco & North Pacific Railroad Company result in the abandonment of the ferry service to Tiburon, as is intimated.

Riverside, Cal.—The Riverside & Arlington Street Railway Company has applied for an extension of its franchise on Main street and down the valley to Arlington, on the gronnd that under the present 20-year franchise it is impossible to borrow money, but by extending the time to 50 years money could be secured with which to construct an electric road.

Elmhurst, Cal.—Since the reconstruction of portions of its [illegible] line, the Oakland, San Leandro & Haywards Electric R[illegible]way has been considering the advisability of entering into more serious competition with the Southern Pacific trains by increasing the speed of its through cars, and accordingly has equipped car No. 20 with two motors, which, under trial, have developed a speed of 42 miles an hour. The experiment was so successful that it is probable that several such cars will be put on shortly between Haywards and Oakland.

Oakland, Cal.—The California Railway, a standard steam road extending from Fruitvale to Laundry Farm, is to be converted into an electric line, and operated in conjunction with the Alameda, Oakland & Piedmont Electric Railway Company. General Electric equipment is to be used, and the Nantasket trolley wire of the John A. Roebling's Sons Company has been purchased for the new line. This wire has an area of 330,000 circular miles.——The Oakland Consolidated Street Railway Company contemplates extending its cemetery branch westward to Shell Mound Park, and the Oakland Trotting Park; the improvements, if made, will cost $25,000.

San Francisco.—The John A. Roebling's Sons Company has sold a complete suit of cable to the Sutter-street system, comprising in all 28,150 feet of 1⅛-inch rope and 36,000 feet of 1¼-inch rope.——Owing to an error in advertising, the sale of the San Francisco and San Mateo electric road has been again deferred. It is said that the road will now bring at public sale

more than 25 cents on the dollar. There is outstanding about $1,100,000 in bonds, the principal holders being C. C. Butler, $400,000; Buck & Olden, $400,000, and two of the Spreckels family, $152,000. It is believed that the bondholders will put in the road, although the Market-Street Railway Company is thought to be desirous of securing it, despite denials that have been given.

Los Angeles, Cal.—An electric line between Los Angeles and Long Beach is under consideration.——The Pasadena and Los Angeles Electric Railway Company is pushing the construction of its new Macy-street line in order to give it an entrance into the center of the city over its own tracks rather than upon the tracks of the Los Angeles Railway Company. W. H. Workman and others have applied for an electric railway franchise, running through various streets from Third street and Stevenson avenue to the intersection of Fourth street with the eastern limits of the city in Boyle Heights. It is hoped to have the road in operation before November.——The Orange Grove Street Railway Company has applied for a franchise from the Park to the cemetery.

San Jose, Cal.—Local capitalists have guaranteed the $50,000 bonus demanded by the Eastern syndicate before building the proposed electric road from this city to Saratoga and Congress Springs. The application for a county franchise is now before the Supervisors, and will be granted shortly, but as it is necessary to advertise the sale of the city franchise for six months the construction will hardly begin in earnest before next fall, and in the meantime it is probable that the machinery and equipment will be purchased and sent out from the East via Cape Horn.——J. J. Scrivner, President of the reorganized Alum Rock Railway Company, has been given until April 9th to make a definite proposition to the Board of Supervisors concerning the intentions of the company regarding the abatement of the steam dummies on the Alum Rock line. It is intimated that if the company does not equip the road electrically, its franchise will be revoked.

INCORPORATION

Tucson, Arizona.—United States Refuse Purifying Company. Capital stock, $500,000. Object: To treat waste material and manufacture illuminating and fuel gas.

Roslyn, Wash.—Roslyn Electric Light Company. Capital stock, $10,000. Object: To supply electric light and gas. Promoters, Donald Thiery, L. E. Sallady.

Tacoma, Wash.—The Bowie-Love Company. Object: To deal in electrical goods, apparatus and supplies. Capital stock, $1,000. Incorporators, C. S. Bowie, M. M. Bowie and William J. Love.

Long Beach, Cal.—The Long Beach & San Pedro Electrical Company. Capital stock, $50,000. Directors, I. E. and E. S. Tutt and Charles C. Glass, of Long Beach, J. H. Braley of Los Angeles, and W. M. Glass of Pasadena.

Los Angeles, Cal.—The Gas Consumers' Protective Association. Capital stock, $25,000. Object: To construct gas and electric light plants. Promoters, W. H. Smith, George C. Rockwell, A. C. Harper, Albert Lindley, W. D. Newell.

Butte, Mont.—The Montana Electric-Gas Company. Capital stock, $25,000. To manufacture and exploit calcium carbide and acetylene. Promoters, T. T. Baker, James H. Monteath and John P. Forbes, of Butte; J. S. M. Neill, George F. Cope and A. J. Davidson of Helena, et. al.

Tacoma, Wash.—The Puget Sound, Mount Vernon, Tacoma & Eastern Railway Company. Capital stock, $2,000,000. Object: To do a general railway, telegraph, telephone and electric light business. Promoters, G. L. Holmes, P. B. Ceasar, L. R. Manning, I. W. Anderson, T. W. Enos, W. C. Wheeler.

Los Angeles, Cal.—It is announced that the Metropolitan Gas Company will soon be incorporated with George H. Bonebrake, A. Jacoby, W. J. Washburn, M. T. Allen, Datus, C. Smith and Henry C. Rew as incorporators, and it is stated that the new company will offer to reduce the present price of $1.90 to $1.35.

San Diego, Cal.—The Bailey Triple Ledge Gold Mining Company; to construct highways, railroads, electric, steam or other motive power and chutes to and from mines. Capital stock, $100,000. L. H. Bailey, Banner, A. C. Mason and O. C. Drauga, of San Diego; E. A. Stanley, of Julian; and James A. Jasper, of Ramona, Cal.

San Francisco, Cal.—The Sterling Electric Supply Company. Capital stock, $100,000, of which $10,000 is subscribed. Incorporators, John R. Cole, O. H. Pennoyer, F. G. Cartwright, F. W. Gale and F. M. Delano.——The Central Development Company, Capital stock, $25,000. Objects: The construction of electric, steam and water plants, etc. Promoters, H. B. Havens, Thomas S. Fish, William C. Staptford, A. K. Durbrow and J. Staptford Jr.

Salt Lake City, Utah.—The Pioneer Electric Power Company. Capital stock, $2,000,000. Officers: President, George Q. Cannon; Vice-President, John R. Winder; Secretary and Treasurer, C. K. Bannister, and they, together with the following, constitute the Board of Directors: Joseph F. Smith, Wilford Woodruff, A. B. Patton, Frank J. Cannon, A. H. Woodruff, F. D. Richards.

Bingham, Utah.—The Bingham Electric Light & Power Company. Capital stock, $250,000. Object: To construct a light and power plant and furnish light and power in the West Mountain mining district, Salt Lake county. The officers and trustees are Frank K. Gillespie, President; O. B. Hardy, Vice-President; James Moffat, Treasurer and Secretary. The company succeeds to the franchise granted O. B. Hardy and W. J. Morehead by the county over public roads for erecting poles, stringing wires, etc.

Spokane,Wash.—The Spokane & Columbia Telephone & Telegraph Company. Capital stock, $75,000. Incorporators, Angus McNish, of Rossland, B. C.; and N. R. Stone, L. Frank Gordon, Jay H. Adams and John D. Farrell, of Spokane. Object: To construct, etc., telephone and telegraph lines in the United States and British Columbia.——The Helen Gold Mining Company. Capital stock, $600,000. Objects: To engage in general mining and electric light business. Incorporators, T. D. Rockwell, W. J. Collins, W. C. Drury, J. C. Haas, W. J. C. Wakefield, Andy Simons and Charles Dawson.

TRANSMISSION.

Salt Lake City, Utah.—The Big Cottonwood plant is to be started on April 15th.

Logan, Utah.—The Hercules Electric Power Company is erecting its pole line between Logan and Hyrum via Providence and Melville.

Los Angeles, Cal.—Wybro & Lawrence have contracted for the placing of two high-speed Sprague-Pratt passenger elevators in the new Wilcox Block.

Mokelumne Hill, Cal.—The Roanoke Mining Company will install its lighting and power plant as soon as the weather will permit. This town will also be lighted therefrom.

Pomona, Cal.—The San Antonio Electric Light & Power Company expects to have non-synchronous, single-phase alternating current motors in operation in this city shortly.

Grass Valley, Cal.—Superintendent Treadwell of the Red Hill mine states that electricity will be used as the motive power in the new mill now under contract to be erected.

Valparaiso, Chili.—Saavadera Penard has ordered two 81-inch Pelton water wheels, each delivering 310 h. p., and to ope-

rate under a head of 364 feet, to be used in an electrical transmission plant he is about to install.

Bingham, Utah.—The power for the operation of the recently incorporated Bingham plant is to be obtained through the Gillespie water right at Big Cottonwood, and electric power is being contracted for delivery to the mines hereabout before next fall.

Twin Bridges, Mont.—Denver and Telluride capitalists are considering the advisability of erecting a big electric power transmission plant to be operated from the water power of Madison river for the purpose of working the gold mines in the northern and eastern parts of Madison county.

Ogden, Utah.—C. K. Bannister is authority for the statement that President Bannigan of the Consolidated Rubber Company of Providence, R. I., has agreed to purchase bonds of the Pioneer Electrical Power Company to the extent of $1,500,000. The contract with Mr. Bannigan has been closed, and under it it is agreed that the plant shall be in operation by December 1, 1897.

Oakdale, Cal.—The Stanislaus Milling and Power Company is this week placing poles and wires by which electricity will be transmitted to Oakdale for power and lighting purposes. The power is obtained by water pressure at Knight's Ferry, 13 miles distant, and is more than sufficient to supply Knight's Ferry and Oakdale. Eventually the wire will be continued to Modesto.

Napa, Cal.—George I. Husmann points out in a communication to the Register that 13 miles distant there is a fall of 300 feet in Rector Creek, and that 15 miles beyond the Sage and Chiles Creeks furnish abundant water at a fall of 300 to 400 feet, suggesting that these water powers are suitably located for power-houses to operate an electric railway that would open up a most productive region.

Colorado Springs, Col.—Wilson & Jackson, of Chicago, who hold the contract for boring a tunnel for an extension of the city waterworks, have ordered the equipment for a temporary transmission plant, consisting of a 3-foot Pelton water wheel operating at 600 r. p. m. under a 600-foot head, and which will drive a 150 kw. 12-pole General Electric 3-phase generator. This plant will be located at the foot of the mountain to be tunneled, and circuits are to be run thence to each end of the tunnel where air compressors will be operated for drills, etc.

Fresno, Cal.—A. L. Fish, of San Francisco, is erecting a Root rotary pump in the Fresno waterworks, which will be run by a 75 h. p. induction motor, to be operated by the San Joaquin Electric Company. This pump will have a capacity of 4,000,000 gallons daily.——The San Joaquin Electric Company is making satisfactory progress in the installation of its plant. The power-house and substation buildings have been completed; the receiver and Pelton water wheel and dynamos are in place, and the machinery is being set up in the substation building, and although the company was incorporated only on April 2, 1895, it is believed that the plant will be in operation within 13 months from the time of its conception.

Riverside, Cal.—The contract awarded by the city of Riverside to the California Electrical Works of San Francisco for the installation of the municipal transmission and lighting plant provides for taking power from the 3-phase generators at the power plant of the Redlands Electric Light & Power Company on Mill Creek. The station is eight miles distant from Redlands and 21.98 miles from Riverside by pole line measurement. The generator is to deliver 3-phase current at 2,500 volts to a bank of special step-up transformers to be built by the Wagner Electrical Manufacturing Company, in which the e. m. f. will be raised to 11,000 volts. Three transformers, each of 100 kw. capacity, are insulated with oil and cooled by the circulation of water in three-fourth-inch pipes coiled around the inner case, the whole being closed in cast-iron boxing. By this means the transformer temperature at full load is guaranteed to be confined within 20 per cent of the temperature of the air. From the transformers the current is to be carried as far as Mentone over the pole line of the Redlands Company, whence the transmission ciruicts will be continued to Roverside over a new line of poles to be built for the city. A single 3-phase transmission circuit will be used consisting of three No. 4 bare copper wires, supported on Fred M. Locke's china insulator and the Locke indestructible steel pins. The transmission loss will be 9¼ per cent at full load. About 1,700 30-foot round cedar poles, 6 inches at the top, will be used, which will be placed 120 feet apart on the transmission line. The butts of the poles are being painted with P. & B. paint, as are also the braced crossarms. From the city limits to First street the the transmission circuits will be continued to Riverside over a inches at the top, thence to the substation on 45-foot poles. Current is to enter the substation at 10,000 volts, where it will be reduced to 2,000 volts, through a bank of three Wagner transformers of the type used at the power-house, except that their total capacity will be 250 kw. From the distributing board are to be run two three-wire circuits for incandescent service and two three-wire circuits for arc lighting service. All lighting, both incandescent and arc, is to be of the constant potential system through transformers stepping down from 2,000 volts to 100 volts, or 50 volts, according to whether incandescent or arc lighting service is used. Helios 14-hour arc lamps are to be used exclusively, and are to be operated from individual transformers, there being 90 street lamps and 10 commercial lamps, in addition to about 1,000 incandescents. The city lighting will consist of 40 arcs on the intersection plan, 25 arcs on the Western Electric mastarms and 25 arcs on pole lines. An experiment is to be made in lighting Magnolia avenue by incandescents, in which 35-foot poles will be placed in the center of the avenue, with brackets, each carrying a cluster of three lights and reflector, there being in all 50 such clusters. There will be about 21 miles of pole line in the city limits.

ILLUMINATION.

Hollister, Cal.—A new engine is being installed in the electric light plant.

Benicia, Cal.—The Solano Electric Company has purchased a 35 kw. Westinghouse alternator.

Grass Valley, Cal.—The Nevada County Electric Power Company is to light the mine of the Providence Mining Company.

Ferndale, Cal.—A. B. Cone has been appointed Superintendent of the electric lighting plant, being installed by F. Nelson.

Bodie, Cal.—Eli Johl is to install an electric lighting plant here, and will probably operate the same by a gasoline engine.

Alvarado, Cal.—The Oakland Water Company is installing a 100-light Westinghouse incandescent plant in its waterworks.

Port Angeles, Wash.—L. D. Stewart has been appointed Manager of the municipal electric light plant.

Carson, Nev.—H. K. Brown has installed a one h. p. Westinghouse incandescent dynamo for lighting his residence.

Coulterville, Cal.—A 60-light Wood bi-polar incandescent mac dynamo has been sold to the Merced Gold Mining Company.

Salem, Or.—An independent turbine is being installed in the Salem Woolen Mills for driving the incandescent lighting generator.

Elko, Nev.—The Elko-Tuscarora Mercantile Company is installing a 15 kw. multipolar 125-volt Westinghouse dynamo for lighting this town.

Honolulu, H. I.—Theodore Hoffman has purchased a 100-light Westinghouse incandescent dynamo, to be installed on a sugar plantation near by.

Oakland Cal.—Charles McClane has been appointed by the Oakland Gas, Light & Heat Company as Superintendent for its Lorin and Berkeley interests.

Placerville, Cal.—The Placerville Electric Light Company contemplates the installation of a large gasoline engine to be used whenever the water supply fails.

San Diego, Cal.—San Diego Gas & Electric Light Company has secured the contract, ending March 31, 1897, for lighting the city with 81 tower lamps and 36 mast-arm lamps.

Palo Alto, Cal.—The Redwood City Electric Company has been awarded a franchise for lighting this place on the condition that the town be fully supplied with lights by April 15th.

San Luis Obispo, Cal.—On March 16th, the stockholders of the San Luis Gas Company elected a Board of Trustees, consisting of H. Brunner, President, and J. K. Prior, J. Barneberg, F. D. Frost and H. J. Edwards.

Long Beach, Cal.—The Long Beach Electric Light Company has secured a contract from the city for erecting 20 arc lights on the wharf. These are to be placed 100 feet apart and burned at a cost of $40 per month.

Watsonville, Cal.—The new steam plant of the Watsonville Electric Light Company is to consist of a 200 h. p. cross compound condensing Buckeye engine for regular service, and two 54-inch by 16-foot return tubular boilers.

Medallin, U. S. C.—One 140 h. p. and one 630 h. p. Pelton water wheels to operate under a head of 150 meters have been ordered of the Pelton Water Wheel Company of San Francisco for use in the municipal electric lighting plant.

Santa Clara, Cal.—It has been definitely determined that the city will own its electric lighting plant, but whether the Santa Clara plant of the Electric Improvement Company of San Jose will be bought, or a new plant installed, is yet unsettled.

Riverside, Cal.—A full description of the municipal electric lighting installation appears elsewhere under "Transmission." ——The Sespe Brownstone Company is installing an electric lighting plant in order to work its quarries day and night.

Nevada City, Cal.—The Nevada County Electric Power Company is endeavoring to secure control or to purchase the electric lighting plants in Nevada City and Grass Valley, and which are owned by K. Casper and John Glasson respectively.

Monterey, Cal.—The Monterey Electric Light and Development Company is in the market for one 60- horse-power boiler, one 50 horse-power engine, and one 500-light alternator, and invites estimates on above for new or second-hand machinery.

Lamiradi, Cal.—The Machinery Supply Company of Los Angeles is installing an isolated plant in the residence of Colonel Robert Northam, comprising a complete steam dynamo and storage battery outfit, together with their refrigerating plant.

Berkeley, Cal.—The Berkeley Electric Light Company is at present running one 88-light, 9.6 ampere Western Electric arc dynamo, and one 1,300-light, 1,040-volt La Roche alternator, while in reserve is held one 60-light Ball arc dynamo and one 500-light La Roche alternator.

Redwood City, Cal.—The Redwood City Electric Company, which has been in operation since January 20th last, has about 600 incandescent lamps wired on its circuits, and will probably have finished all wiring and installation by June 1st. At present its nightly load averages 250 lamps, the price for current being 1 cent per lamp per hour.

Fresno, Cal.—The contract for street lighting for one year from April 15th has been awarded to the San Joaquin Electric Company for $6.95 per lamp per month, all night lighting, which is $3.55 less per lamp than the city is now paying on the 1 o'clock schedule, and the new lamps are to be of 2,000 c. p., while the present ones are of 1,200 c. p. The bid of the Fresno Gas & Electric Light Company for the same service was $6.95.

Pasadena, Cal.—At the annual meeting of the Pasadena Electric Light Company, on March 3d, the Board of Directors for the ensuing year was elected as follows: F. C. Bolt, J. S. Torrance, A. W. Armstrong, L. P. Hansen, L. C. Torrance. The Board of Directors elected its officers as follows: L. C. Torrance, President; L. P. Hansen, Vice-President; J. S. Torrance, Secretary; San Gabriel Valley Bank, Treasurer. It is the intention of the company to make further extensions during the summer upon such streets as may hold out inducements for house-lighting and generally extend their business.

Santa Ana, Cal.—The application of J. Buel for an electric light franchise has revived the question of municipal ownership, which is again being considered by the Board of Trustees. ——C. M. Holmes, President of the Santa Ana Gas & Electric Company has announced a reduction in gas rates, under which the residence rate for cooking and lighting will be $2, and the lighting rate on a scale varying from $3 to $1.50, according to consumption.——George E. Nolan, a Los Angeles electrician, has reported to a committee of the Board of Trustees, by whom he was employed, that the total valuation of the steam, electric and pole line equipment of the Santa Ana Gas & Electric Company is $3,025.

Stockton, Cal.—The Stockton Gas & Electric Company has secured the city lighting contract, terminating August 1, for $11.70 per lamp per month.——The Stockton Gas & Electric Light Company will soon commence boring a new gas well on a corner of Anderson and Pilgrim streets, from which it expects to derive a flow of nearly 100,000 cubic feet of gas per day from a depth of 2,000 feet. Considerable new piping is to be laid to supply the southeastern portion of the city from the new well. The company has a gas well at the intersection of Hunter and North streets, and another at the corner of Fremont and Grant, besides the big Haas well in the western part of the town. All of them are to be connected, which will equalize the pressure throughout the mains.

Los Angeles, Cal.—The West Side Lighting Company, by E. E. Peck, Manager, has bought a 1,000-light Wood alternator and 1,925 lights capacity in Wood transformers. The company's plant, which is situated just outside the city limits, is furnishing arc and incandescent service at the University, Harper tract, etc., and has applied for a franchise that will enable it to engage in city lighting.——The Los Angeles Electric Company has bought a car-load of Westinghouse transformers in assorted sizes.——The Lester F. Scott electric lighting franchises will probably revert to the city on April 28th next, as its owners have thus far failed to fulfill the conditions under which it was granted.——Griffes & Sumner have secured the contract for wiring the Hollenbeck home.

Alameda, Cal.—The supplemental steam plant which A. L. Fish is to place in the municipal lighting station is to consist of a 450 h. p. cross compound Buckeye engine, and four 72-inch return tubular boilers.——John A. Britton, Secretary of the Oakland Gas Company, has written a letter to the City Trustees, in which he emphatically denies that the company or any one connected therewith authorized or suggested the suit which has been brought against the City Trustees to restrain them from improving the municipal electric light plant.——The City Electrician's report on the municipal lighting plant for February shows the operating expenses to be as follows: Construction account, $60.70; salaries, $412.50; labor, $116.50; running expenses, $115.32; coal oil and waste, $339.60; total, $1,044.32. The income is estimated as follows: Private consumers, $297.55; City of Alameda, $35.35; Free Library, $27; arc lights to city, $750. This leaves a profit to the city of $65.28.

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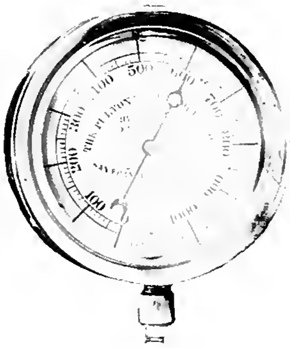
The Fresno Transmission Plant

BY GEO. P. LOW



NE of the first surprises experienced by the visitor to the power house of the San Joaquin Electric Company results from standing him opposite the wheel house of one of the Pelton wheels within the pit while the attendant in the station starts up the equipment, and the nerves of the visitor must be strong if they can restrain him from fleeing terror stricken from the heavy "cannonading" that accompanies the starting of the plant. He is, of course, aware that the installation is operated under a higher head of water than any other electric transmission plant in the world, but he is not prepared for an outburst resembling that of artillery, and his first thought will be that something is wrong—that the enormous receiver beside him is breaking away, and that but a moment stands between him and eternity, but he finds his distress a source of amusement to the station hands, and his chagrin secures satisfaction in the determination that he will get some one else in the same predicament, and "have the laugh on him." In truth he has received his first lesson of the terrific energy represented in a column of water which throws the gauge to above 600 pounds, and the rattle as of the "machine guns" is readily explained by the fact that while idle the chamber of the nozzle is filled with air, and upon opening the gate, the water rushes in, filling the lower portion of the nozzle first, then compressing the air in the upper part, and in the churning of the air that follows, bubble after bubble of air compressed to over 600 pounds per square inch is released, forming a discharge of pneumatic musketry, that, reverberating through the canyons, bears tidings to the ranchers even six miles distant, of the starting of the water wheels.

THE CANAL AND RESERVOIR.

Nature appears to have foreseen the necessities

Figure 1—View of Reservoir Mountain, Pipe Line and Power House Site of San Joaquin Electric Company.

which have led to the development of water powers and their utilization by the means of electricity, and the hand of man could not have executed a more favorable plan than that upon which the water power of the San Joaquin Electric Company has been developed. High in the Sierras and well within the winter snow line, the North Fork of the San Joaquin River makes its precipitous descent to the valleys below. Until well in the summer, each valley adds its quota of water to the stream, but only the waters from the larger canyons have perennial flow. Of these, the North Fork and the South Branch of the North Fork of the San Joaquin River, were selected as head waters. No dam or structure of any sort other than simple fluming marks the diversion points, the flumes being simply extended into the banks at the side of the streams, or are well bolted to bedrock, and continue thence to their confluence shown in Figures 2 and 3. The canal thus formed is about seven miles in length, of which 3,000 feet is of wood flume, and the remainder is ditching. Waste gates have been placed in the canal at every 4,000 feet, and the canal has a capacity of 70 cubic feet of water per second.

A great portion of the flume has been built on solid rock, forming the bed of the river. The severe freshets that occur during the winter months necessitate the utmost rigidity in securing the flume to the rock. This was done by anchor bolts consisting of heavy iron split at the end for from four to five inches, and into which steel wedges were started. The bolts, with the wedges started, were then driven into holes that had been drilled into the solid granite, and the spreading thus caused by the wedge rendered the withdrawing of the bolt practically impossible, but greater security was given by filling the holes with melted lead. So firm has this construction proven that the storms and freshets of the past winter have not affected the flume in any way. The ditch is built throughout in a reddish loam, which settles and packs so that no seepage occurs. A portion of the ditch is shown in Fig. 4.

THE RESERVOIR

An interesting feature in the development of the water power consists in the peculiar topographical formation of the ridge upon which the reservoir has been located. This ridge extends out as a spur from the backbone of the main North Fork Ridge, and is bounded on one side by the North Fork of the San Joaquin and on the other by Fish Creek. It is around this main ridge that the canal is carried, and Reservoir Mountain, as the spur ridge is aptly termed, consists practically of a table land with three sides very precipitous. The location of the reservoir, together with its elevation, is clearly shown in Figure 5. In the background are seen ridges of the main chain of mountains, while in the valley between them and the reservoir runs the San Joaquin River. The area of the reservoir is about eight acres, and it was formed by throwing up an earth embankment to a height of eight or ten feet for a distance of about 500 feet. Its storage capacity is sufficient to operate the transmission plant to full capacity for between five and six days.

FIGURE 2—ARCH FLUME STRUCTURE OVER THE NORTH FORK OF THE SAN JOAQUIN RIVER, SHOWING CONFLUENCE OF THE DIVERSION FLUME INTO THE MAIN FLUME.

The favorable location of the reservoir can be better understood by reference to Figures 1 and 5, which are really companion photographs. Figure 1 is made from a photograph taken well down on the mountain side shown in Figure 15 and the reservoir is directly over the crest at the top of the mountain in Figure 1. Water may be supplied to the pipe line either from the reservoir or direct from the flume, an additional 800 feet of which has been constructed to subserve this purpose. The head of the pipe line, together

with bifurcating gates, pressure box and air stand pipe, is shown in Figure 6.

The pipe line consists of practically three sections, according to the variety of pipe used. The first 1820 feet is

FIGURE 3—ANOTHER VIEW OF THE CONFLUENCE OF THE DIVERSION FLUMES, SHOWING SITE OF THE NORTH FORK DIVERSION, A PORTION OF THE DITCH AND FLUME OF THE SOUTH BRANCH OF THE NORTH FORK DIVERSION AND AN OVERFLOW GATE IN THE MAIN FLUME.

of riveted pipe, 24 inches in diameter, the first 960 feet of which is of No. 12 steel, and the remainder is of one-fourth inch steel. Then follows the second section, consisting of 400 feet of standard converse lock-joint welded pipe 20 inches in diameter and having lead joints. The last section, which is also 1,800 feet in length and has a diameter of 20 inches, consists of lap-welded pipe, with flange joints made tight with rubber packing. The entire length of the pipe line to the receiver is, therefore, 4,020 feet. The first section was built by the Risdon Iron and Locomotive Works, and pipe for the remaining sections was furnished by the Dunham, Carrigan & Hayden Company, and was made by the National Tube Works of McKeesport, Pa.

As stated, water may be conveyed to the pipe line either from the reservoir or the canal direct and to prevent litter from being carried down the line, the openings of the pipe lines leading to the pressure box have been provided with bell mouths, each 6 feet in diameter across the mouth and covered by a massive screen containing 1,800 one-half inch holes. From the pressure box a 12-inch stand pipe, with suitable valves, extends to a point above the level of the reservoir. The bifurcating gates, as well as all other gates and relief valves, are of Risdon make.

Much difficulty was experienced from unappreciated causes in the erection of the pipe line, and being about 4,000 feet in length and running over different geological formations various expedients had to be resorted to to secure stability. At some portions the pipe line has been buried to a depth of from five to eight feet in the soil. Elsewhere it is supported on short bridgings but the general construction consists of bolting the pipe firmly to the massive granite bed-rock. Stay rods, or holding-back bolts, are not used, but instead the pipe is held down in the manner above described for holding down the flume. With the pipe line, however, the split bolts are sulphured into the granite to a depth of from five feet to seven feet, and to the bolts are screwed semi-circular, flat iron bands, $2\frac{1}{2}$ inches by $\frac{5}{8}$ths inch in size, placed on top of the pipe.

The pipe line was built from the ends towards the center and as the time for closing in the gap approached a new obstacle appeared. Early in the morning, before sunrise, the gap between the pipe ends, and which is best termed "the cold gap," was 7 feet 8 inches. In the afternoon, and about sunset, this gap would close to exactly 7 feet, giving "the hot gap" due to the expansion of the pipe by the heat of the sun.

Section 1, consisting of 24-inch riveted pipe, was built first, the construction being begun at the lower terminus and laid from the bottom upward, the pipe being held in place with heavy timbers known, by boiler-maker s as "dead men." The lap welded or 20-inch pipe was laid from the receiver upwards, leaving a gap between the reducer

FIGURE 4—A PORTION OF THE MAIN DITCH.

piece or taper joint on the riveted pipe and the last bell of the converse lock joint pipe. Early in the morning, before sunrise, this gap, best termed "the cold gap," was 7 feet 8 inches. In the afternoon, and about sunset, the gap would close to exactly 7 feet, giving "the hot gap" due to the expansion of the pipe by the heat of the sun. The closing of the gap was thus resolved into the problem of finding the minimum temperature of the pipe, then closing the opening and filling the pipe with water before sunrise. All tools and materials were gotten ready, and at 2:30 a. m. the gap measurement was taken, a piece of lap welded tubing was cut to fit and then driven in place tightly. A loose bell was used and the rib chipped out so that it slipped freely over the edge of the pipe at the point of splicing, and when the connecting piece was in place and slipped over, the joint was filled with lead on both sides and caulked, thus completing the pipe.

FIGURE 5—CREST OF RESERVOIR MOUNTAIN, SHOWING RESERVOIR AND FLUME LEADING THERETO.

One is not to be disappointed in the natural expectation that the installation and operation of a pipe line of this character would be attended by many peculiarities if not phenomina entirely new. Operated as it is, under a head of 1,411 feet, and having imposed upon it the trying conditions incident to the control of hydrostatic pressure of 609 pounds per square inch, the requirement that electric generators shall be operated at a practically uniform speed necessitates the exercise of the greatest ingenuity in the design of water wheel governors and the San Joaquin pipe line, being strictly the pioneer in this direction, has had imposed upon it both the use and abuse that would naturally fall upon the first undertaking of the kind. It is with a view that the difficulties experienced may be obviated in future installations of this character that considerable space is given to them.

Students of accoustics may care to know that to halloo into the mouth of the empty pipe line invariably causes seven distinct echoes. The normal flow of water in the pipe is at the rate of $1\frac{1}{2}$ feet per second, and the present plant in the station, when operated to full capacity, does not consume sufficient water to enable the determination of the friction head. The velocity of the water from the $1\frac{1}{8}$ inch nozzles used is something over 9,200 feet per minute, and nothing is more impressive of the terrific energy of water at this head than a recital of some of the difficulties that have been encountered in controlling it. The general features of construction that have become well established by the erection of many plants operating under heads of from 500 to 600 feet or less were first carried out in this installation, but subsequent experiences compelled their

FIGURE 6—BIFURCATING GATES, PRESSURE BOX AND AIR STAND-PIPE AT THE HEAD OF THE PIPE LINE.

abandonment and the design of special features to satisfy the conditions found to exist. In the wheel pit for instance, and in the tail race all masonry construction is of the most solid character. The wheel pit was carefully closed over by heavy planking, and upon turning on the water it refused to go out the tail race and along the bottom of the ditch, but instead rolled up the sides of the pit or followed up the water wheels to the plank covering and along the under side of the planks it rushed madly out, almost horizontally, for a distance of sixty feet, where it struck a great granite boulder, and was lost in spray.

The jets strike the wheels at an angle of 45 degrees from the horizontal, and, the nozzles being deflecting, the impact water strikes the bottom of the wheel pit with terrific fury. After two days operation the water had cut under the concrete and into the seams of the bedrock, coming out in the powerhouse and outside of it. To obviate this a 14-inch steel pipe, 4 feet in length and having a heavy steel plate across the lower end, was let into the bottom of the wheel pit in line with the jet, the idea being that the pipe would fill with water and form a water cushion to take up the blow. Instead of doing this, however, it merely reversed the direction of the stream, and the waste water landed on top of the power house, not taking the usual course. Then some one recommended that the wheel pit be dammed up so as to carry two or three feet of water, which would tend to prevent the emptying of the cushion pipe, with the only difference from the preceding experiment being that in addition to the waste water the water impounded in the wheel pit was also landed on the station roof and thereabout. Nevertheless the "water cushion" pipe was allowed to remain, but it was filled level full with concrete and the bottom was completely floored over with 3-inch planking which was sheathed for 3 feet about the nozzle with $\frac{3}{8}$-inch steel plates. At that time the water was slightly muddy and considerable granite sand had been washed into the tail race and as a result in less than three days a $\frac{1}{4}$ inch jet which had been left in, had worn its way through the steel plate and the 3-inch planking, and was at work upon the demolition of its old enemy, —concrete and masonry. The heroic method of feeding a fresh cast-iron plate $1\frac{1}{2}$ inches in thickness to it as often as necessary has now been resorted to as the best solution of the problem.

SOME EXPERIENCES IN HYDRAULICS.

The question of wheel regulation at once constitutes the most serious encountered in the whole installation and the method now being tried consists in tapping the main pipe line at a point sufficient to give a head of 200 pounds at the power house. At this point an auxiliary tank with an independent six-inch pipe is to be erected, and from the constant, or unvarying water pressure thus realized, the constant speed Pelton wheels for operating the governers will be driven. In addition to the Pelton differential deflecting nozzle governer, other governers are to be tried, among which will be the Lighthipe electric governor, soon to be described in these columns. The weight of the water contained in the pipe is approximately 317 tons. The end thrust thrown upon the receiver is about 93 tons, to withstand which four $2\frac{1}{2}$-inch stay bolts solidly bolted to the receiver have been imbedded in beveled abutments, as shown in Figure 7. The receiver itself is 57 feet in length, with a diameter of 30 inches; it is constructed of $\frac{3}{4}$-inch flange steel, with a tensile strength of 60,000 pounds and an elastic limit of 30,000 pounds. External and internal butt straps are placed thereon in five-foot courses. It is riveted throughout with 1-inch rivets and

FIGURE 7—POWER HOUSE OF THE SAN JOAQUIN ELECTRIC COMPANY, SHOWING RECEIVER AND MODE OF WITHSTANDING THE END THRUST OF THE PIPE LINE.

the stay bolts for withstanding the end thrust are welded to ¾-inch boiler plates, 10 inches in width, that are in turn riveted to the shell of the receiver. The receiver carries two relief valves, and all mountings are of phosphor-bronze, the nozzle saddles being of cast steel. Before leaving the Risdon Iron Works, where it was built, the receiver was tested to 800 pounds hydraulic pressure, which was considered noteworthy; but since its installation it has been subjected to a far greater strain without injury, as will appear shortly.

It did not take long after water had been run into the pipe to demonstrate that while water at a head of from five to six hundred feet may be considered a liquid, yet at a head of 1,400 feet it becomes a solid with the strength of the hardest steel. The gates and relief valves ordinarily used were placed upon the equipment. The relief valves in particular had, up to that time, been considered perfection, and the balanced internal pressures were so thoroughly worked out as led to the belief that they would operate satisfactorily under any pressure, but the vital point of the friction which ensues from the contact of metal with metal when under high pressure was under estimated, and as a consequence the relief valves are practically inoperative. It is the belief of the engineer in charge that at high pressures water must be relieved by something cumulative. The use of compressed air is impracticable, because of the fact that the air will be forced into the water and the practice finally adopted for protecting the equipment from water hammer, consists in the adoption of gates for controlling the rate of opening and closing, rather than in the use of relief valves.

At the power house the gates are controlled by hydraulic rams actuated by water taken from the pipe line. As originally installed, any one of these rams opened the gate so as to cause a fluctuation of 170 pounds from the normal, and here is noted a phenemena due to the elasticity of the pipe. With the original equipment upon opening the gate the pressure would drop 90 pounds below normal, then rise to about 80 pounds above normal; then drop in wave motion to say 75 pounds below normal and so continue for from 20 to 30 seconds, until the normal pressure was reached. Upon closing the gates precisely the same conditions would arise with the exception that the initial change would be 90 pounds above normal. The acts of opening or closing the gates are therefore identical, so far as water shock is concerned and so perceptible is this fluctation or "breathing" of the pipe, in the first or wrought steel section of the pipe line, that upon sitting astride of it one can feel its "breathing" as though it were a giant reptile.

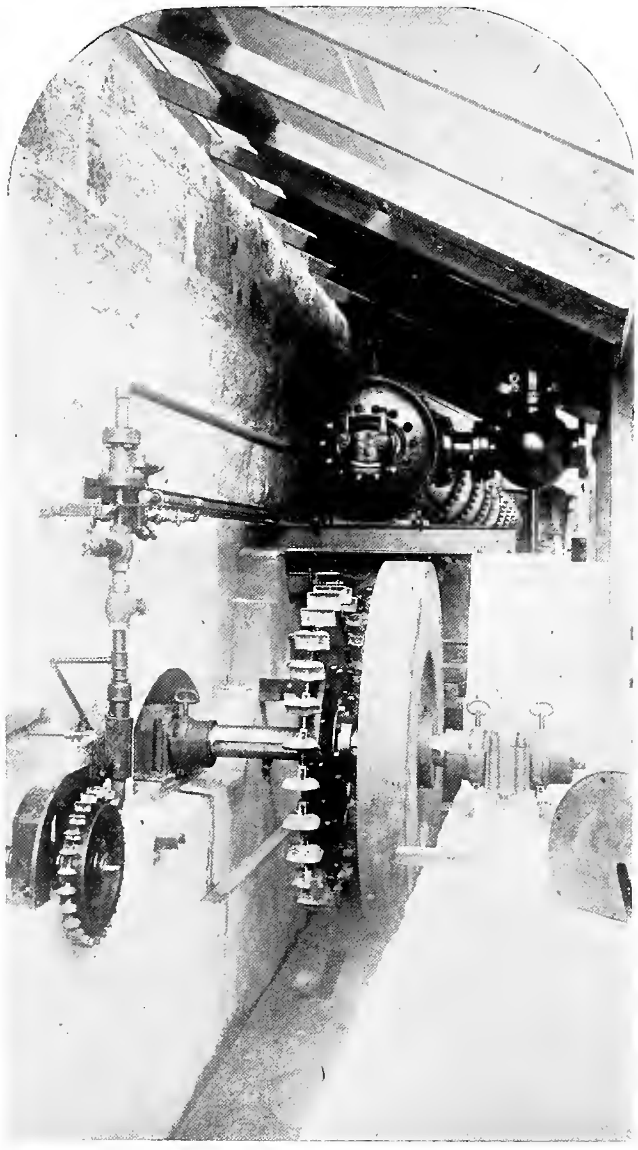


Figure 8 — Pelton Water Wheel Mountings. Showing Fly Wheel, Exciter Wheel and Lower End of the Receiver.

The fluctuation of 170 pounds was altogether too great to admit of satisfactory operation and accordingly it was determined to reduce the speed of the ram in opening or closing the gates by reducing the size of the exhaust outlets in front of the piston. Accordingly the diameter of these orifices (one at each end) were reduced to ⅛ of an inch each, which reduced the water shock to 50 pounds above and below normal. But 3-32-inch orifices were eventually adopted which increased the time of opening or closing the gates to 30 seconds and reduced the water shock to 30 pounds above and below normal. These devices were entirely automatic in their action, giving absolute satisfaction in the handling of the head.

The experience with this pipe line has, as stated, made it plain that when water is under high pressure in a large column it becomes the equivalent of a solid bar of equal weight, standing on end, and it is from handling this column of water, 4,000 feet in length, weighing 317 tons and exerting a pressure of 609 pounds, that the conclusion is reached that this column of water must be handled in exactly a similar manner as would be devised for handling

a solid column of like dimensions, namely: time must be an element in starting and stopping the column in order to overcome the "Water shock," or combined force of the momentum force of the water itself, and the expansion and contraction of the containing vessel. With this idea of "time," as a simple thought, the volume should be set in motion and brought to rest by a device that would be the equivalent of withdrawing an inclined plane, the taper of which is represented in the time required in getting the column in motion, or in other words, to handle water successfully under extremely high heads there is only one true and safe way, and that is by means of screw gates, as by this means the column of water can only be started or stopped very slowly. If this method is employed water shock and at the same time relief valves for taking care of the same, will be an unnecessary problem.

Under the head of relief valves for very high pressures the conclusion reached is that any method whereby water is discharged is more liable to constant increase of water shock than otherwise, as it has a tendency to increase the velocity of the water column, which in itself is the primary cause of water shock, and hence the conclusion is that devices for handling high heads should be so arranged as to make water shock absolutely impossible, however careless operatives may be.

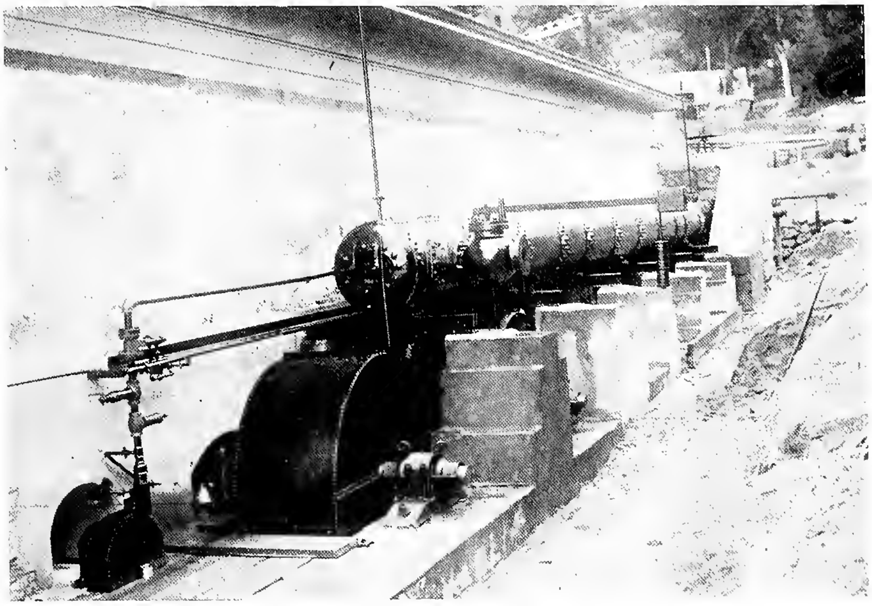


FIGURE 9—THE COMPLETED RECEIVER AND PELTON WATER WHEEL PLANT.

As shown in Figure 9 the receiver is mounted alongside the power house and directly beneath it are the Pelton water wheels constituting the power plant. Independent single jet Pelton wheels are furnished for each generator and exciter, and two smaller wheels operate a line shafting at constant speed for driving the governor mechanisms. In the main wheels the Pelton wheels have an outside diameter of 57 inches and each wheel carries 27 buckets bolted to its periphery. The speed is 600 revolutions per minute. On the same shaft with the main wheel is seen the 6000 pound fly wheel 60 inches in diameter with which each wheel is provided. On the periphery of the fly wheel is shrunk a heavy cast steel band two inches thick to prevent its disruption at high speed from centrifugal force. As the water wheel and generator outfit is direct connected and as the armature weighs about 7000 pounds, the total

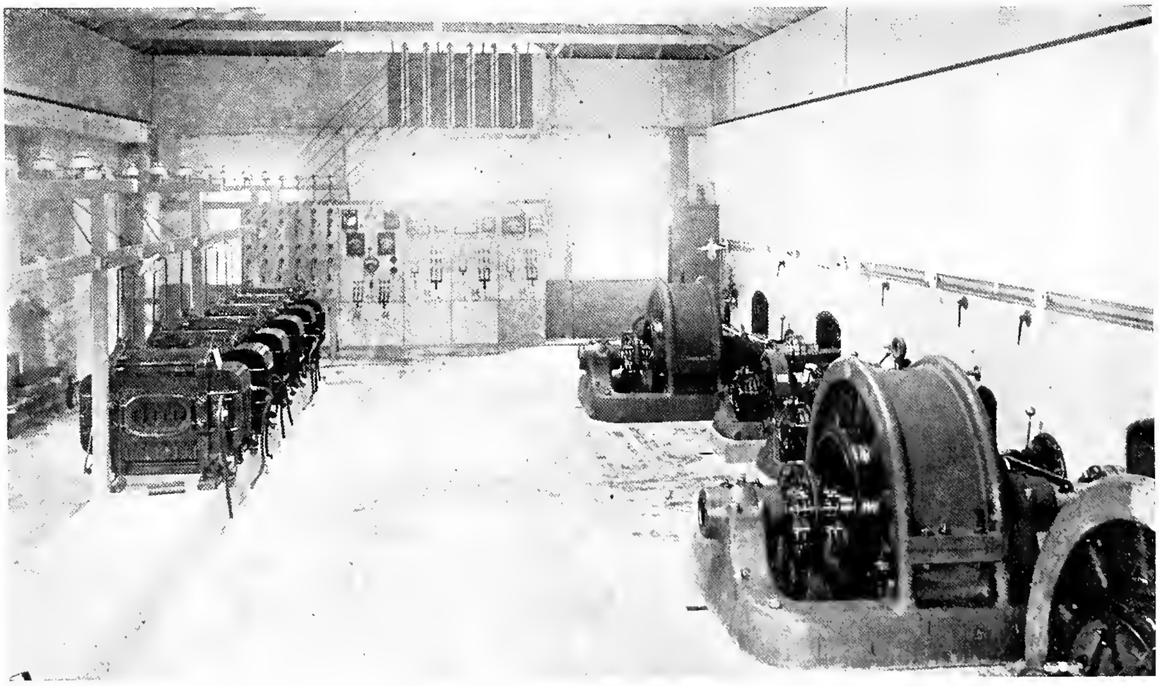
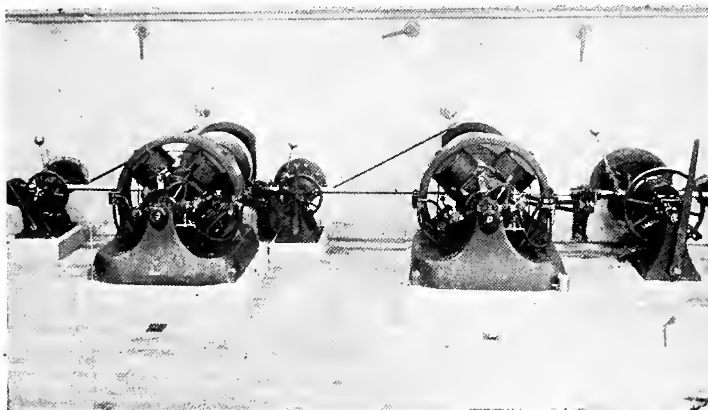


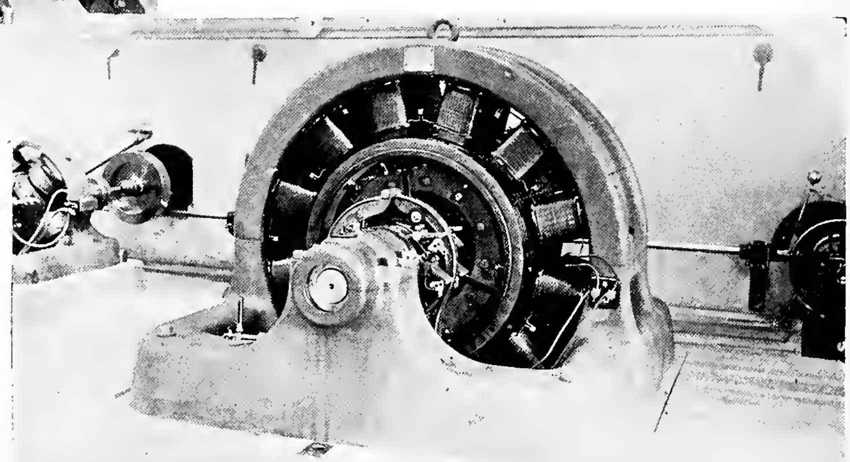
FIGURE 10—GENERAL VIEW OF THE INTERIOR OF THE POWER HOUSE.

mass available for fly wheel effects aggregates 13,000 pounds. The diverting nozzle mode of regulation is used but it is probable that the conditions prevailing will necessitate the devising of special regulating apparatus to meet the conditions imposed.

THE POWER HOUSE.

The power house is a model of central station architecture; it is 76 feet long by 36 feet in width, and as appears in Figure 7, is of granite. Within it are three 340 kilowatt multipolar General Electric 3-phase generators delivering current at 700 volts and 60 cycles per second to the low potential switchboard shown in Figure 14, whence it is carried to the bank of nine 125 kilowatt transformers, delivering 3-phase current to the line at 11,000 volts through the high potential switchboard. In addition the station carries two $12\frac{1}{2}$ kw. multipolar exciters, each being of sufficient capacity for the operation of the entire plant. The method of high potential wiring used in the power house is shown in detail in Figure 13.





Figures 11 and 12—Showing Exciters and Constant Speed Regulator Shafning and One of the 340 k. w. Generators, Respectively.

The power house and sub-station are protected by Bell lightning arresters and choke coils, the detail of which are best shown in Figure 18. Each transmission line upon entering the station is taken through a choke coil consisting of 150 feet of the same size of wire as used in the line. In the present instance, No. 3 B. & S. copper wire covered with weather proof insulation is coiled into a ring fifteen inches in diameter, the whole ring then being well taped. From the coil the high potential circuit is carried to the high potential switchboard and thence to the step-down transformers. At ordinary periodicities, such as 60 cycles per second as used in the Fresno plant, the self-induction of these rings is inappreciable, but at the enormous frequencies of a lightning stroke the coils prove effective in protecting the apparatus beyond them and in forcing the lightning to take the path to earth provided through the lightning arresters. Each of the transmission lines is provided with a lightning arrester as shown and these consist of 40 non-arcing metal cylinders screwed to a base and hence removable, the surface of each being separated 1-32 of an inch from that of the adjoining cylinder. The ground discharge from the bottom of the arrester is carried to earth by a copper ribbon one inch in width by 1-32 of an inch in thickness. Similar rings with suitable arresters are also placed on the 1000 and 2000-volt circuits extending from the sub-station.

THE POLE LINE.

The entire pole line, whether on the mountains or over plains is constructed of square sawed redwood poles, 12 by 12 at the butt and 6 by 6 at the top, the length varying from 35 feet to 40 feet according to locality. On the plains the poles are set 120 feet apart, while on the mountains the separation varies according to the contour, but approximates 100 feet. Standard six-pin seven-foot cross arms are used. These are placed $20\frac{3}{4}$ inches apart and the pole lines for the transmission proper carry two such cross arms for the transmission circuits and one additional 48-inch cross arm for the telephone service, the latter being $62\frac{1}{4}$ inches below the lower high tension cross arm. Certain portions of the pole line are eqipped with a third cross arm for carrying the vineyard circuits of the company.

The poles were hauled and erected by the San Joaquin Electric Co. and the task was beset with difficulties owing to the mountainous country and the frequent blasting necessary in digging holes. Throughout the timbered portions of the route a 20-foot clearance has been cut, as have all trees that could by any possibility fall across the circuit. In addition to this clearing the San Joaquin Company constructed a wagon road $4\frac{1}{2}$ miles long and a bridge having a 100 foot span and 340 feet of approaches.

The transmission circuits consist of two 3-phase 3-wire sets which may be used independently or together as desired. All wires are of No. 3, B. & S. soft-drawn copper. These two sets are divided by the pole, and the top cross arm supports two wires of each set, the third wire being immediately below. The lines are arranged so as to form an equilateral triangle having twenty-four inches on a side and the main line is transposed every 40 poles, or approximately every mile. Standard triple petticoat porcelain insulators are used and the method of tying is peculiar. A No. 8 soft copper tie wire is used. This is about 20 inches in length and in placing the line wire in the top groove

the tie wire is placed with it and its ends are carried around the insulator groove in the same direction, each end making a complete circle before being wrapped. The wires were strung by a line corps of the General Electric Company, under Mr. B. O. Boswell, Superintendent of Line Construction, and although the line construction did not begin until January 13th last, it was finished on February 23d, twenty-three men being employed in the work. Only one trouble has yet occurred to the line and that was due to a defective insulator which caused a short circuit equivalent to a load of 6000 lamps at Fresno. The circuit was at once cut out, the entire load was thrown upon the other set of lines until the following morning, when the trouble was found and remedied.

The results obtained from the telephone circuit carried over this pole line are truly marvelous. Hunning's dust transmitters of a type that do not infringe the patents of the American Bell Telephone Company are used over a circuit of No. 14 hard drawn copper wire supported by porcelain knobs. The telephone circuit is transposed at every fifth pole through the use of Locke's transposition insulator, and the line is absolutely quiet despite the facts that its length is 34½ miles and that the initial potential is 11,000 volts.

THE SUB-STATION.

The transmission lines enter the sub-station in Fresno in the manner clearly shown in Figure 18. The high potential switchboard there shown is not accessible and the switches are thrown by the use of a long bamboo pole with a ring on the end. It is difficult to measure the length of the arc drawn out on throwing the switches because of irradiation, but even at full load it does not appear to be in excess of one-half of an inch. The high potential switchboard affords the means for throwing any of the various types of step-down transformers on to either one or both of the two sets of transmission lines. These step-down transformers are all of the air-blast type and are divided into three sets, each designed for a separate purpose. Three 125 k. w. transformers with secondaries wound "Y" deliver current at 115 volts to the 4-wire commercial incandescent circuits. The second set consisting of three 75 kilowatt transformers with secondaries wound "delta," deliver current at 1000 volts for operating power circuits through the use of induction motors. The third set, consisting of three 40 kilowatt transformers, also wound "delta," delivers current at 3000 volts for the vineyard and other outlying districts. A 5 kilowatt induction motor

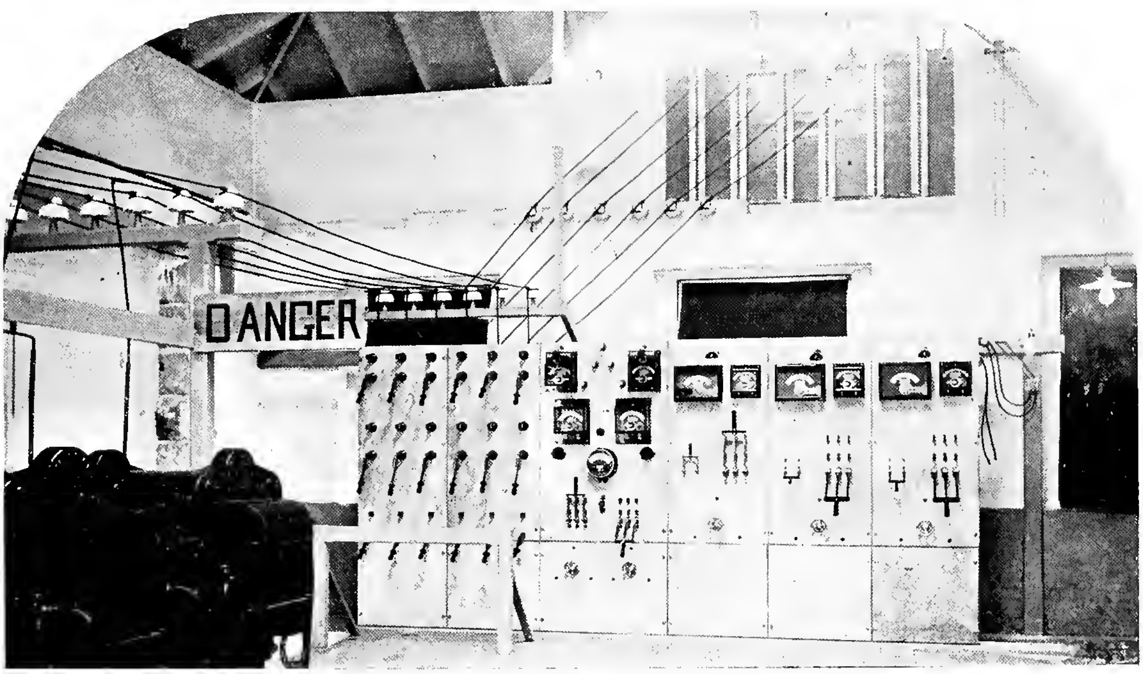


FIGURE 13—GENERATOR AND HIGH POTENTIAL SWITCHBOARDS AT THE POWER HOUSE, SHOWING METHOD OF HIGH POTENTIAL WIRING AND LIGHTNING ARRESTERS.

drives a Sturtevant blower for the cooling of the transformers and the fact that this motor is belted to the blower forms the only inharmonious feature in the equipment of the sub-station.

From these transormers the current is carried to the low potential board which is not fully completed at the present time. This board was designed by Mr. Ernest I. Dyer of the General Electric Company and consists of ten panels all but one of which are now in operation. Of these, five are for controlling the low potential incandescent service; one panel controls the 3000-volt vineyard circuit; one controls the Chinatown 1000-volt incandescent service; two panels control the 1000-volt mains for the outlying residence lighting; and the last panel controls the induction motors driving the Brush arc light machines shown in Figure 19. Each of these arc lighting sets consists of a three-phase induction motor direct coupled to an 80 lamp, 2000 candle power, Brush arc lighting dynamo, run at 700 revolu-

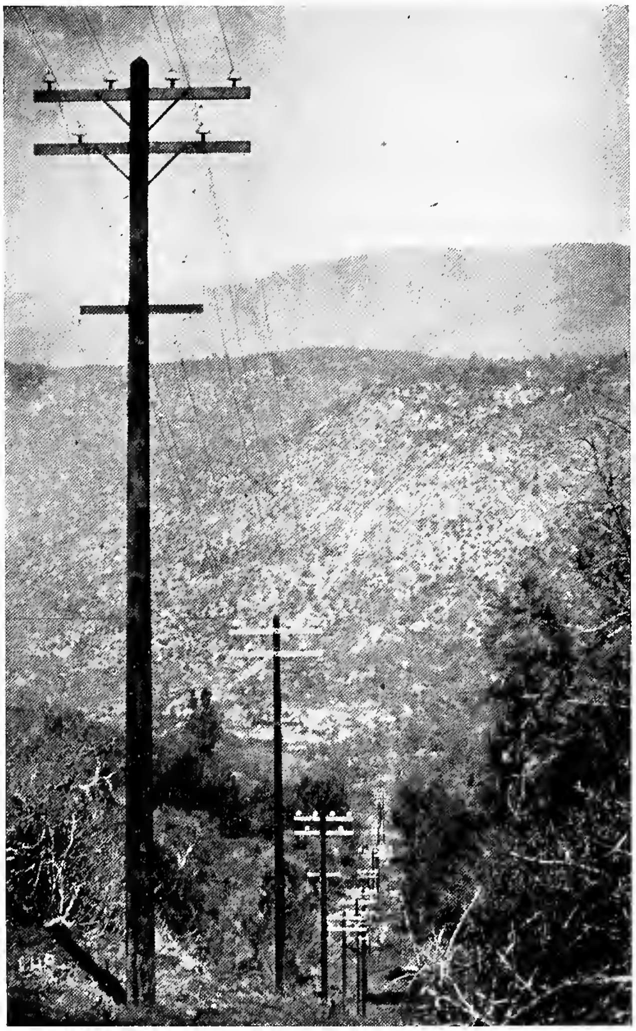


Figure 14—A Portion of the Mountain Pole Line, With the Power House Site, Pipe Line and Reservoir Mountain in the Background.

tions per minute. A special switchboard for the arc lighting service and which is not shown in the illustrations is of one panel carrying six circuits and provided with two Weston ammeters and four type "A" Thomson-Houston lightning arresters, together with the usual accompaniment of spring jacks and the differential equipment of the new regulator for Brush "Z" type dynamos. The 1000-volt power service is taken direct from the transformer to the line and the Chinatown service is rendered through a special 3000-volt transmission to Chinatown, where step-down transformers reduce the potential to 115 volts for distribution on the four-wire system.

The entire business section of the town has been wired up uniformly with the four-wire system. No. 0000 B. & S. bare copper wires are used almost exclusively as feeders and are so arranged that wires to the south and west of pole lines are the neutral wires and those adjacent thereto are the "A," "B," "C" wires respectively in the order of their sequence. This arrangement is due to Mr. J. N. Smith, Chief Electrician of the San Joaquin Electric Company.

The regulation of all circuits, whether for power or incandescent service is effected through potential regulators introduced into each outgoing circuit and by means of which the voltage is regulated at centers of distribution.

RATES OF SERVICE.

A surprising feature in connection with the San Joaquin Electric Company is the remarkably low rate at which electric service is rendered. The company has secured the municipal lighting contract for lighting the city of Fresno with 2000 c. p. arc lamps at the rate of $6.45 per lamp per month, all night and every night. Electric power is delivered approximately at the rate of $64.00 per h. p. per year 24-hour service, and incandescent service is rendered by meter rates or flat rates. The rate for meter service is 15 cents per kilowatt per hour, with discounts varying from 5 per cent to 25 per cent, according to consumption. In residence lighting flat rates prevail exclusively and the novel system has been inaugurated of charging for service according to the location of the lamp at the following rates per month:

Sitting room, 30 cents per 16 c. p. lamp per month.

Halls, dining room, or kitchens, 25 cents per 16 c. p. lamp per month.

Parlors, pantries, and barns, 15 cents per lamp per month.

Bed and bath rooms, cellar, garret, 10 cents per lamp per month.

Figure 15—View of the Pole Line Near Fresno City.

The very favorable rates which have been established by the San Joaquin Electric Company for power service have already brought it several large contracts, principally among which is that of the Sperry Flour Mills, which is being operated by a 150 kilowatt synchronous motor running at 600 revolutions per minute. The city water works will also be run by electric power and a 75 kilowatt induction motor belted to a Root rotary pump having a capacity of 3,000,000 gallons daily has been installed. This latter equipment will displace a 4,000,000 gallon triple expansion Holly steam pump now used. At the present time the company is burning about 1600 incandescent lamps and has contracts secured for 1100 additional lamps. It is also prepared to enter upon its street lighting contract as soon as its pole lines have been completed, and is ready to deliver power as fast as motors are received.

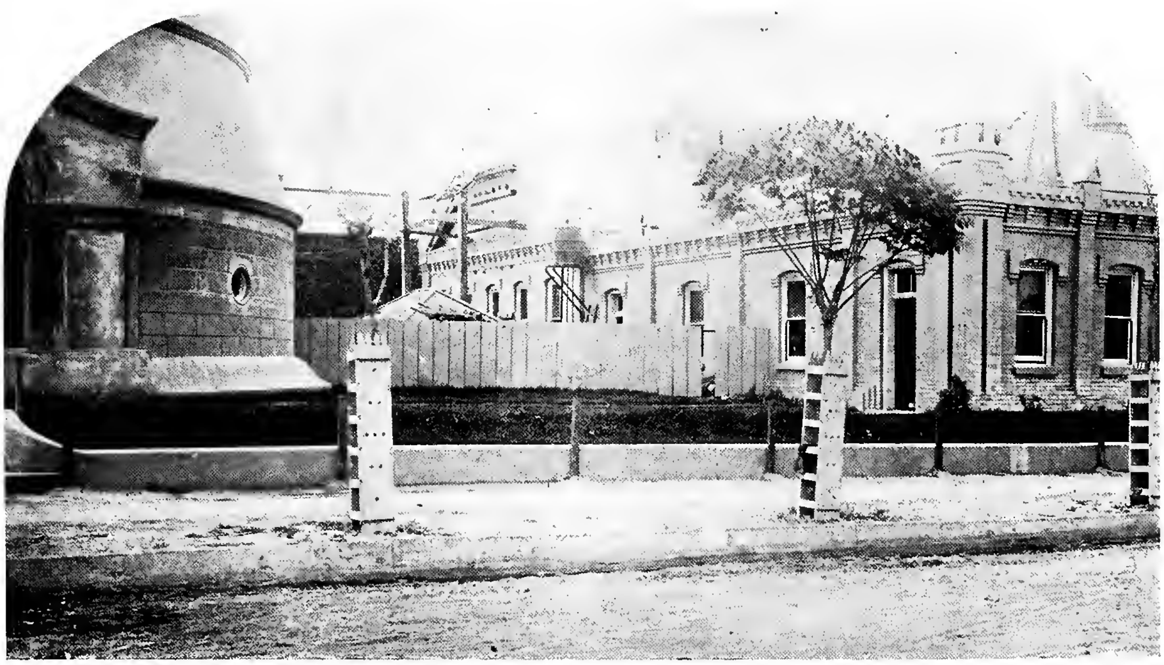


FIGURE 16—REAR VIEW OF THE SUB-STATION IN FRESNO, SHOWING MODE OF ENTERING HIGH POTENTIAL CIRCUITS.

PROMOTERS OF THE ENTERPRISE.

The conception of the plant of the San Joaquin Electric Company is due to Mr. J. S. Eastwood, a Civil Engineer of Fresno, who from his familiarity with the mountainous regions in the Sierras, back of Fresno, had long been impressed with the magnitude of the water power there available, and as soon as the feasibility of electric transmission over long distances had been commercially assured, he began the organization of a company for the purpose of developing water power and transmitting its energy to Fresno. Fresno offered a particularly favorable field for the introduction of electric light and power, because of the high price of fuel and the fact that the influences of the lighting interests theretofore existing had been bent in the direction of restricting the means of lighting to the use of gas and arc lamps. As a result of Mr. Eastwood's efforts, Mr. J. J. Seymour, President of the Fresno Water Company, became interested in the enterprise and they soon organized the San Joaquin Electric Company. This was accomplished on April 2nd, 1895, since which date the scheme has been perfected and the plant is now practically completed. It would be difficult to find a proposition of such magnitude that has been handled with greater celerity, and the installation stands a fitting monument to the genius and energy of California promoters. While the business detail has been handled mainly by Mr. Seymour, as President and Manager Mr. Eastwood has had charge of all engineering and superintendence, and his ideas are impressed so thoroughly throughout the various branches of the work that he can not but have won for himself lasting fame in the development and control of high heads of water.

The electrical apparatus used throughout is the three-phase type of the General Electric Company, and the entire installation was placed under the supervision of Mr. J. A. Lighthipe, Chief Engineer of the Pacific Coast office of the General Electric Company, and who was assisted by Mr. C. O. Schaefer, Superintendent of Construction of the sub-station; Mr. A. C. Jewett, Superintendent of Construction of the power house, and Mr. B. O. Boswell, Superintendent of Line Construction.

This describes the electric transmission plant which exceeds all others in the world in the combined points of size of plant, distance of transmission, and height of head of water used. It has an unfailing supply of 50,000 h. p. of water available.

Electro-Therapeuty

THE SCIENTIFIC APPLICATION OF ELECTRICITY IN MEDICINE—II.

BY W. N. WILLIAMS, M. D.

In reference to the human body as a conductor of electricity, it may be interesting to state that the resistance from hand to hand is from 2000 to 5000 ohms. which is more than twice the resistance of the Atlantic cable. A battery of five primary zinc carbon elements, equal to 10 volts, in passing through 2000 ohms, gives five milliamperes, which would be a result difficult to attain under ordinary circumstances.

For various reasons the Faradic or induced current is not so often indicated or applied in electro-therapeutics as the galvanic current. As yet there is no scientific means of determining its physiological efficiency or its therapeutic measurement, hence it has made but little progress as compared with other currents during the past twenty years. Among the specialists, there is a tendency to favor those instruments giving varying resistances and electro-motive forces from different lengths and thicknesses of wire. A standard instrument much used at present is the Dubois-Reymond coil, which is so arranged that the sec-

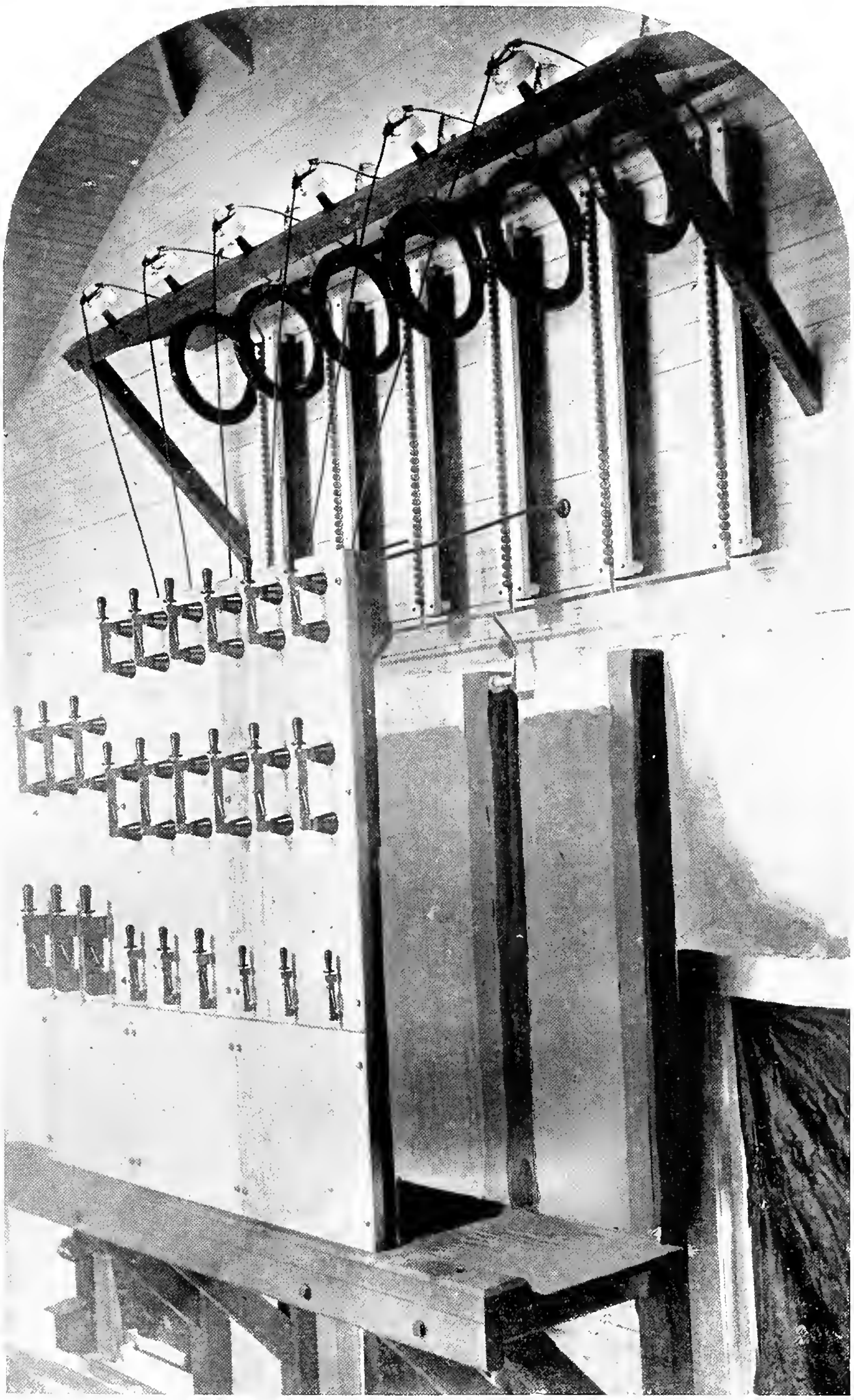


FIGURE 17—HIGH POTENTIAL SWITCHBOARD AT SUB-STATION, SHOWING LIGHTNING ARRESTERS AND CHOKE COILS.

ondary slides over the primary coil, by means of a rack and pinion adjustment. The therapeutic effect of the secondary coil, which is of long fine wire, is sedative and pain-relieving, and many of the coils now made have secondary coils, of fine wire wound in various lengths, but such coils, however, are not in general use.

The various electrodes for applying the Faradic current have changed but little from the older forms. Electrical massage has become a useful and effective means for treating some forms of nervous disease. Faradism is used in this treatment and is applied by placing one electrode in a fixed position, the other electrode being the hand of the operator, passed over the skin and muscles of the patient, thus applying the electricity and massage with the same hand. The dry cell agreeable and equally developed at either pole, and patients who will not endure the weakest current from a secondary Faradic coil, will cheerfully submit to an application of this sinusoidal current.

The construction of the Kennelly machine is on scientific principles. The field frame is of laminated iron, supported by twelve castings, and has twelve poles. On each pole is a spool with two series windings of wire, the secondary or inner winding having eight layers of fine wire, and the outer or primary winding having two layers of coarse wire. By this arrangement the armature, when driven, transforms the continuous primary current into alternating current waves in the secondary circuit and by the arrangement of the armature surface these waves are made sinusoidal.

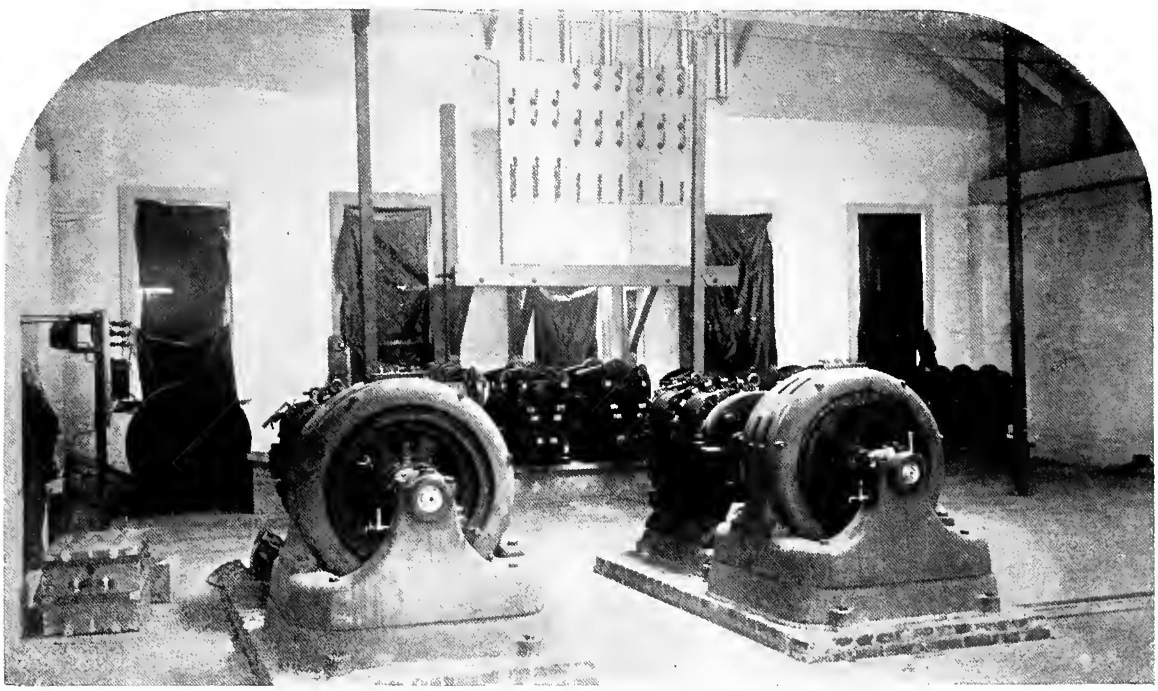


FIGURE 18—AN INTERIOR VIEW OF THE SUB-STATION, SHOWING HIGH POTENTIAL SWITCHBOARD, STEP-DOWN TRANSFORMERS, BLOWERS, INDUCTION MOTORS AND ARC DYNAMOS.

Faradic batteries are largely replacing the old style of fluid cell battery—and where a portable battery is required they are far superior in every respect. Many styles of the dry Faradic battery are made so small and compact that they may be easily transported in the physician's overcoat pocket, or in his hand satchel with other instruments.

With specialists, the tendency seems to be in favor of the new sinusoidal machine as a substitute for the Faradic coils. Dr. Aposoli, the great French electrotherapeutist, was among the first to recognize the superiority of this current for medical purposes over that of the secondary current of the Faradic coil.

Prof. A. E. Kennelly has produced and placed upon the market a machine for producing this current. It runs very smoothly and produces a current of a most pleasing character, with an entire absence of that pricking, painful sensation characteristic of the secondary current from Faradic coils. In the Kennelly sinusoidal machine, therefore, there is an entire absence of this painful, jerky, interrupted current. As there is no interruption in the circuit, it is a simple, harmonic wave, undulating equally above and below the line of zero potential, hence the sensations produced in the Kennelly machine instrument are soft,

For every revolution of the armature twelve complete periods are generated, and with a maximum speed of 4,800 revolutions per minute the frequency may be carried to 1920 alternations per second. The alternator is arranged to be driven by a motor on a 120-volt circuit, and the primary winding is excited by the same, controlled by a lamp rheostat, thus affording independent graduation of frequency in the secondary currents. This current has been very successfully used by Dr. Apostoli of Paris.

Professor d'Arsonval first discovered the powerful action of this current on all living bodies submitted to this inductive influence. The best method of applying it is to place the patient, free from all contact with electrodes, in the circuit of a larger solenoid traversed by these currents. The patient being thus completely insulated, the currents which circulate in his body by auto-condition have their origin in his tissues, the body playing the role of a closed induced circuit. By these methods the physiological discoveries of d'Arsonval are verified, and we are able to prove the powerful influence of these currents upon the vasomotor system. Although they produce no sensation and have no apparent effect on the motor or sensory nerves they are found to exert a powerful action on all the nutritive functions.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY
F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

ECONOMIES IN COAL CONSUMPTION

The central stations belonging to electric lighting plants and street railroad companies upon the Pacific coast are so large and well built that one should perhaps hesitate before criticising in any particular their methods in handling fuel or generating steam. Much capital has been expended upon water cooling plants for condensers and the subject of steam economisers has been so carefully worked out by our central station engineers that one would not expect to find any question concerning the use and quality of coal neglected in station construction. At the same time an examination of many of the large central station plants situated upon the coast, will disclose the fact that they are generally employing expensive Welsh coal to the almost entire exclusion of the cheaper fuels which may be obtained nearer home. It is true that the coals used are the highest in calorific power to be found in the coal mines of the world, but at the same time it is equally true that the expense of these coals per calorie is greater than that of the inferior native products, the reason of their choice being that with the existing furnaces the production of steam is less expensive with the more costly coal.

While this fact reflects credit upon the engineers who have charge of the existing plants, at the same time it is not equally to the credit of those who were called upon to design the plants or upon those who may modify these plants after they have been designed. The construction of a furnace necessary to burn anthracite coal is undoubtedly less expensive than the construction necessary for an equally high efficiency in the combustion of cheaper grades of coal, and where the difference in price of the two coals does not warrant a great furnace expenditure, there is no doubt but that the coal of the highest calorific power is the cheapest from every consideration. This is the state of affairs both throughout the South of England and along the Atlantic seaboard, while the practice among central station managers along the Mississippi river has clearly indicated that within reasonable limits the cheapest coal is the cheapest steam producer, whenever the engineer of construction has carefully studied the low grade fuels available and has installed boiler furnaces adapted to their combustion with high economy.

The difference in price between high and low grade fuels is even larger upon the Pacific coast than it is along the Mississippi river, and yet Western engineers have not thoroughly attacked the problem of the economical combustion of low grade fuel. The newer power houses of the Market Street Railway Company in San Francisco have been equipped for the combustion of cheap coal and there is no doubt that such an equipment will prove its wisdom when the yearly coal bill has been considered. Through the influence of these plants, we may hope to see this subject carefully taken up by central station designers with the unquestionable effect of reducing the cost of energy delivered by the station. The present practice of buying coal by the amount of steam produced is one which tends to crystalize all the old errors that have been made in original furnace design, even if the method of thus paying for the coal supply is followed it is a better practice and better contracts should result from the careful overhauling of boiler furnaces and the construction of such furnaces as will allow the employment of the cheapest coals on the market at their highest efficiency.

COMBINATION FOR GENERAL GOOD

The recent announcement of consolidation between the electric and gas companies of San Francisco compels one to consider whether the general consequences of such movements act for the benefit of the customers, as well as for the stockholders. The term "combination" or "trust" has come to mean much oppression throughout the country on account of the fact that many large organizations have endeavored to use their power in a manner which is oppressive to their patrons. Such action has often been required by the excessive capitalisation of the concerns entering into combinations, as well as on account of the fact that these combinations are at once plunged into both ruinous competition and unwarranted litigation, brought about by the odium attached to the name of "combination." It is obvious to any one who has considered the lighting situation in a large city that more advantages are to be gained from a great combination than from excessive over-competition, since consolidated companies stand toward the public in the light of a municipal corporation, while their private management guarantees an operation far more economical than can be obtained by any municipality.

It is impossible to say that any great company depending upon a city for its franchise can be divorced entirely from politics, so that in comparing it with the business

undertakings of a municipality we have in both cases political expense which in either case may or may not become an excessive burden. This political burden is, as we have already stated, very frequently the reason for excessive charges by a great corporation, and we believe that should the people of the cities devote the same attention to preventing the blackmailing of such business enterprises by the politicians as they at present devote to the private affairs of the corporation itself, the expense of the corporation would be so far reduced as to enable it to furnish power or gas at rates which would be below those possible with the two companies in competition, as well as at rates below any which the city could establish, should a municipal plant be installed. If politics could be eliminated altogether from the business management of the lighting industry, the consolidated company would depend upon its good behavior for patrons and non-interference in its business, and there is no doubt but that the ultimate effect of such consolidation would then be of unmixed benefit to its patrons.

TESTING UNDER GROUND CABLES

The quality of cables to be used in underground construction in high potential working has become a consideration of increasing importance since the large cities are demanding the condemnation of the overhead electric lines. In view of this fact it is important to obtain as much as can be had of the history of underground construction and as wide a knowledge as possible of the experiments that have been tried in cable manufacture. In this connection it is well to point out the action which is apparent in the breaking down of any electric cable by high potential current. With all cables insulated by the use of fibres or any diaelectric excepting the solid gums like gutta percha and vulcanized India rubber, there seems, upon experimentation, to be found what might be called a critical breaking down point which is dependent upon the character of the insulation but not upon it thickness. By this we mean that the saturated fibre insulated cable will fail under the application of a certain value of electro-motive force and an increase in the thickness beyond a certain limit will not appreciably increase the resisting power of this particular insulating material. This anomalous result may perhaps be explained by a reference to the experiments which have been performed upon cables insulated with paper, in which it has been found that the breaking down point is lower with dry paper insulation than with paper insulation which has been saturated in spite of a lower insulation resistance, and that the breaking down E. M. F. for a cable insulated with dry paper is approximately the same as the E. M. F. necessary to spark across the freshly cut end off a paper insulated cable, thus indicating that the breaking down of any cable takes place through the movements of electrified particles carrying a charge from the core to the cable sheath until finally charring takes place when conduction follows. Air bubbles, which are spaces containing rarified air within the insulation of the cable, are found also to have an important bearing upon this value which may be called the critical breaking down strength of the insulation. From these considerations a caution can be issued to all users of underground cable that their cables for high F. M. F's. should be chosen, not so much for the strength of the insulation resistance as shown by a galvanometer test, but by their physical characteristics of the dielectric and perfection of manufacture as may be indicated by high potential tests carried to the breaking down limit. The dry air paper insulated cable a few years ago obtaied many friends, and at the present time we find that it is reappearing in England, where the engineers will undoubtedly try their own experiments and will probably ultimately arrive at the same conclusions as have been arrivd at in this country, that the breaking down strength of paper cables unsaturated is less than that of the same cables saturated with any simple liquid dielectric. A little care and a little study of such problems will always guard against many errors that may be committed by those who are unwilling to examine carefully the history of the apparatus they are intending to use.

TRAFFICKING IN TRANSFERS

We called attention a few months ago in our columns of Passing Comment to the demoralizing effect of transfers on street railroads in increasing the opportunities of stealing by motormen and conductors, but we did not expect so soon to see the moral disadvantage of such a system exemplified in San Francisco and extended to the general public, but we are compelled to call attention to the shameful lack of moral sense possessed by the patrons of the roads in that city, and advocated by some of the more important newspapers. We refer to the practice of handing transfers to news boys, who use them as premiums in aid in the sale of their papers. Such practices are nothing more nor less than theft, and no matter how we may feel towards the monopoly which operates the railroad system, we cannot but see that such practices must have a demoralizing effect not only upon those who practice this system of stealing, but also upon the general public, when the newspapers are led by it to advocating the time honored principle that stealing from a corporation or from the Government is no crime.

Small straws show the direction of the wind, and the public sentiment which will accept such principles from the daily papers is surely to blame for thefts in municipal management as clearly as are the corrupt officials themselves. The convenience of a transfer to the traveling public and the premium which they put upon riding should be sufficiently well understood by the railroad management, but at the same time much remains to be hoped for in this system until the element of dishonesty has been eliminated altogether from its use.

Passing Comment

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

THE SPECTACULAR IN ELECTRICAL ENGINEERING.

The managers of the Electrical Exhibition in New York are striving after spectacular effects and have developed two of the most striking plans that have heretofore been seen and yet perhaps the most remarkable thing concerning these exhibits is that they will not occur to electricians as being in any way noteworthy or the results problematical. These achievements merely mark the thorough management of great electric corporations, rather than remarkable effects of electrical engineering. The first of these results was the opening of the exposition itself, as performed by an electric signal sent from New York to San Francisco, and thence back to the exhibition building, where a relay was operated and the machinery of the exposition started. The second startling result obtained is the operation of a small model of the Niagara power plant by an electric motor driven from the generators established at the Falls. A further employment has been made of the current so transmitted across the State of New York to send messages from the exposition building through the cables to Europe, thus completing the transmission of Niagara power, not simply across the State of New York, but across the Atlantic Ocean as well. Of course, no effort will be made in this experiment to produce an economical transmission of power over so great a distance, but the fact that the transmission can be made shows that the science of electrical engineering has solved the long distance power transmission problem without reference to the distance and that the question of any transmission is one not of engineering, but of financial results.

"THE DOOM OF THE CABLE IN SAN FRANCISCO."

In the February number of the Street Railway Journal is a very significant article by S. L. Foster, entitled "The Doom of the Cable in San Francisco." It has been many times stated and as often denied that there was an intention on the part of the management to replace all of the San Francisco cable lines with electrical construction and the people have fancied to read in such a change some infringement of their rights. Since every touch of this idea must be avoided by the street car company, it has persistently denied the existence of an intention to alter its locomotive system. Apparently, however, from this article, it has at last determined to announce its intention of gradually changing its entire system to electric haulage and we should consider the consequent effect upon the city and its traffic.

The experience of other American cities has proven that the service given by electric roads is generally preferred to that given by cable roads, with the exception of those in New York and Chicago, where particular conditions render the cable roads acceptable. In New York the traffic is from North to South through the axis of the island. New Yorkers are unused to transfers and do not demand transportation off the line of the main railroad. In Chicago the cable roads connect densely populated suburbs with the business portion of the city, these suburbs lying in three different directions, north, south and west; but if now we refer to the cases of Boston and Philadelphia, we will find cities in which the direction from the business section to the residences of business men is indefinite, and in consequence it is necessary for the tram lines to give equal transportation facilities to many points radiating from the business center, which can be done only by the means of electric traction. Very much the same case is found in San Francisco, and as the city gows, new demands will be made on the railroad company for transportation which will require extra line construction in advance of increased traffic. By furnishing more cable roads the company would be required to operate many suburban lines at ruinous expense, and the public would be called on even more often than at present to exchange from car to car, thus increasing the already intolerable transfer nuisance. On the other hand, with electric traction, it would be an easy matter to send out cars from the business section to any one of many suburban points without materially increasing the operating expenses and at the same time reducing the annoying necessity of frequent changes from car to car. The attitude of the daily press has made the public at present unduly suspicious of any move made by the Market Street Railway Company, but we believe that the near future will demonstrate that the change from the cable to electricity has been made by the company as much for the convenience of its passengers as to increase its own revenue.

OVER ZEALOUSNESS.

An incident illustrating the inconsistency sometimes appearing in editorial utterances is found in a recent number of a lyocal electrical contemporary, which in discussing high potential switchboards, states that "the Folsom-Sacramento transmission plant was stopped for four hours recently by damage done to the high potential switchboard by lightning. It was due to the failure on the part of the contractor to have the lightning arresters put in. They should have been in place when the plant was first started up." Then the succeeding paragraph observes that the amount of power required for operating hoists in mines is an important consideration, and that inoperative hoists result from the tendency of mining superintendents to underestimate the power actually consumed. The local contemporary continues: "This old story has again been repeated in the history of the plant just started in Sonora county, for supplying power to the Rawhide Mine. The company furnished the machinery called for, but the mine superintendent had under-estimated the power required to operate the hoist and trouble followed. If a consulting electrical engineer had been employed at the start there would have been no trouble."

The suggestion may be in order that in view of the fact that the Folsom-Sacramento transmission was placed under the direction of a San Francisco firm of consulting electrical engineers whose abilities are understood by engineers in California, if not in the East, it would be well to at least place such discordant observations in different portions of the paper that the sensibilities of the parties concerned may not be offended.

Literature.

CATALOGUE OF BOOKS ON ELECTRICITY, ELECTRIC LIGHT, THE TELEPHONE, ETC.—For sale by D. Van Nostrand & Co., 23 Murray Street, New York. Distribution gratuitous.

We have just received the revision of D. Van Nostrand & Co.'s Catalogue of electrical books bearing the date of April 1896, which presents some distinct features as a book catalogue, and on account of arrangement into subjects forms a work of particular interest and importance. This company was the first one in America to issue a complete catalogue of electric literature, and at the present time its catalogue is the most complete published by any bookseller. In the present edition they have abandoned the old arrangement of an alphabetical list in favor of an author-catalogue subdivided into sections according to a very satisfactory subject classification which makes the catalogue at once valuable in studying a given subject, and renders the book easier to refer to in case any particular investigation is undertaken. Glancing over this catalogue, one is also struck by the fact that within the last two or three years many works have been published giving systematic treatment of the various problems in electrical engineering which have heretofore only been presented in a fragmentary manner, without true reference to actual practice.

THE DYNAMO, by S. R. Bottone. Ninth edition. New York: Macmillan & Co.; 116 pages. Price 90 cents.

We could have no better proof of the interest taken by amateurs in the manufacturers of experimental dynamos, than the continued success of this little book, which has carried it through nine editions since the first publication in 1887. The manner of treatment adopted by the author is one calculated not solely to enable an amateur to manufacture a small generator, but to lead him to the study of the principles underlying the action of such a machine. At this late day, however, we would expect to find enough experimental workers capable and willing to manufacture a more perfect dynamo to warrant the introduction of an appendix, showing the importance of making a laminated armature and describing the method of carrying this out, especially since the author has found it advisable to give methods of compound winding, as well as complete drum and ring aramture windings with many-part commutators. Such criticism, however, represents a wish for a more complete work, rather than a criticism of that which is done in this volume, where both the methods of construction and methods of study are well laid out and carefully described to such completeness that the merest novice will be able to follow the instructions and obtain a satisfactory machine capable of delivering a small current and to gain from the work an elementary knowledge of dynamo machine construction.

SYNOPSIS OF CURRENT LITERATURE DURING 1895. By Max Osterberg, E. E., A. M. New York: D. Van Nostrand, 1896, pp. 143. Price, $1.

The agitation for an index of periodical literature during the past few years which has been carried on by Mr. Fred DeLand in his publication "Electrical Literature," by Professor Sheperdson before the American Institute of Electrical Engineers and by many technical journals and technical societies throughout the country is bearing practical fruits in this volume extracted from the pages of "Electric Power" under the editorship of Mr. Osterberg, which has the great advantage over similar previous publications of being issued so early in the year following the publication of the articles indicated and for the reason, if for no other, will be found of great value to electrical engineers. In order to condense the extent of the work no attempt has been made at a complete index of all the articles indicated and for this reason, if for no but only those which seem of the greatest importance to the editor, which plan has the distinct advantage of bringing the publication within a reasonble limit of size and price and will in time make a series of such books so published from year to year immensely valuable. At the same time the selection made bears the distinct impress of the editor's mind, which is further impressed by the arrangement of the articles under the various headings employed; no other method perhaps is possible for publication in book form and the very limitation of the articles renders the classification employed easy to follow.

The ideal synopsis of technical literature will not be reached until such a synopsis can be published by each journal covering its own pages, arranged upon cards without headings that may be filed in the library catalogue of each subscriber to the journal according to the particular system of classification which the subscriber himself will choose. Until this system of indexing journals shall be adopted throughout technical literature we must rely upon some such a catalogue as that which we have before us. Typographically the synopsis of Mr. Osterberg is commendable for its clearness by which aid we may rapidly run over the headings in any section of the book without being confused with the digests of the articles themselves, though these digests are clearly enough printed to allow easy perusal and immediate reference to the original papers. Technical literature is often at fault in adopting ambiguous headings for the articles published, and here again we find that Mr. Osterberg's work is to be commended for the banishment of the titles printed in favor of short titles which are more descriptive of the articles themselves.

Certain phases of electrical engineering have unfortunately appealed but little to this editor and the articles which treat of these subjects have either been altogether omitted or included in departments where they must be rediscovered by those who intend to refer to them. The theories of currents and current measurements we find here well classified as are all articles relating to the manufacture of generating and transmitting machinery; particular processes such as metallurgy, electro-therapeutics and electro-chemistry are carefully indexed, but we fail to find any headings bearing directly upon line or circuit installation. The subjects of fixtures, subways, fuses, circuit breakers and other matters connected with them have been apparently entirely omitted, although as we all know important additions have been made to the literature of these subjects during the past year.

In conclusion, we must commend the admirable arrangement of the book in its indices and general system and we feel that we can assure the author that he has performed a work of great value which, as he no doubt feels, can be made complete only by an active co-operation of others who are capable to undertake a similar work iu the lines which he has omitted.

Physics

THE DETERMINATION OF A LIGHT UNIT.

BY D. W. MURPHY

Within the past few years the determination of a light unit which should be suitable as a standard with which other light sources could be compared, has received no little attention in the scientific world. We are accustomed to define the amount of light given off by a source as being equal to that of some number of standard candles, by a standard candle meaning one that consumes a unit mass of wax, paraffine or other combustible substance in a unit of time. The amount of light from such a standard is necessarily a variable quantity, as it depends upon the purity of the substance consumed, and, as is the case with all flames, upon the meteorological conditions of the atmosphere. The former source of error can be reduced to a minimum

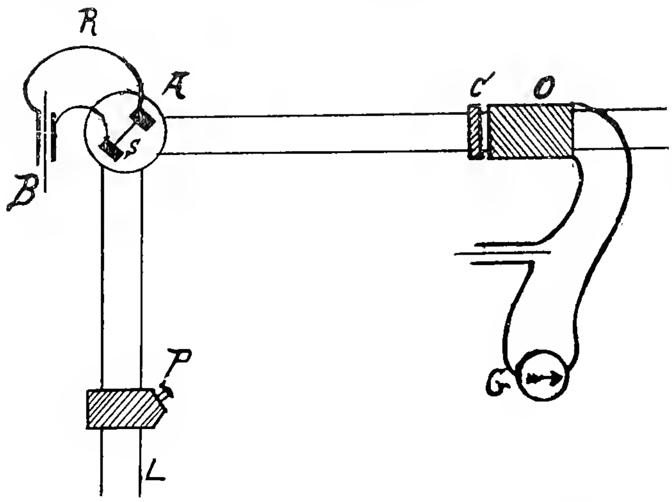

FIGURE 1—Scheme of the Lummer-Brodhum Photometer

by using a well-defined substance; and corrections based upon experimental data can be made for atmospherical changes, reducing the results to standard conditions. The final test, however, for such a unit as a standard, is whether in the hands of different observers concordant results can be attained. This has not been attained by any form of candle yet used. Measurements upon a paraffine candle in use for many years and adopted as a standard in Germany show that these variations were not less than 10 per cent.

The principal requirements of a light unit that will be serviceable as a standard are, first, that it shall be constant, and second, that it be simple enough in construction that it may be readily reproduced. The first requirement is one of a purely scientific nature, and may aid in the solution of the problem from a practical standpoint just in proportion as the second requirement can be realized. Since no standard yet prepared has given constant results in the hands of different observers, various attempts have been made to find some more reliable source with which comparisons can be made. To this end various light units have been proposed; among the most prominent of these should be mentioned the Heffner lamp and the pentane lamp of Vernon Harcourt. These are both open flame lamps, the substance used in the first being amyl acetate and in the second pentane. M. Viole has proposed as a unit the light emitted from a square centimeter of platinum at its temperature of volitization. This, while it would seem to promise good results, has not met with success in the hands of other observers. Another standard proposed independently by Professor S. P. Thompson and Mr. James Swineburn was to use the light given off from one square millimeter of the crater of the positive carbon in the electric arc lamp. None of these standards, however, together with the many more that have been proposed, have fulfilled the conditions required of a practical light unit. At the International Electrical Congress held in Chicago in 1893 attempts were made to bring about the adoption of a unit. Of those considered by the committee the Heffner and pentane lamp were the most promising. Objections were made to the Heffner lamp that the flame was too yellow in color, and to the pentane lamp that the commercial pentane is not sufficiently well defined. Finally the objection was made to all open flame lamps that they are too much affected by the temperature, pressure and moisture of the air.

The committee recommended that while its members realized the great progress made by the construction of these lamps, yet it was unable to recommend either as a light standard. If further invited all nations to make reseraches in common on practical, well defined standards, in the hopes of realizing an absolute unit. Since that time some further progress has been made and other forms of units have been proposed. The most of these, however, are mere proposals of what may be a constant source, but lacking careful experiments to recommend them to favor.

The following method of determining a light unit and the one which seems to promise best results so far attained has been used by Professor Lummer and Dr. Kurlbaum of the Physikalische Reichsawstalt. As a unit is used the light emitted from a square centimeter of platinum kept at a constant temperature. The platinum strip is heated by an electric current; the temperature is defined by the relation of the amounts of its radiations under different conditions. The one is the total radiation of the heated platinum, the other consists of the rays which pass through a definite absorption medium. So long as the ratio of these two remain the same the temperature of the source is constant. The amounts of these radiations are measured by means of the bolometer. The principles of this instrument, the use of which has been far reaching in physical investigations, were first worked out by Suanberg and later, but independent of him, by Langley.

The essential part of the instrument consists simply of a high resistance placed in an electric circuit; on this high resistance part of the circuit radiations are allowed to fall and the change in the resistance due to the temperature change measures the intensity of the radiations.

The apparatus used by Drs. Lummer and Kurlbaum consisted of a bolometer, with galvanometer and other

accessories for indicating changes in resistance, together with the light source, which consisted of a strip of platinum of approximately 25 millimeters wide, 60 millimeters long and 0.015 millimeters thick, so mounted that it formed part of an electric circuit. The platinum was heated to a high temperature by an electric current, whose strength could be regulated by a variable resistance. The light source was mounted on a form of optical bench, with two arms at right angles to each other. Upon the one arm the bolometer was mounted, and upon the other a photometer. By rotating the light source, which was at the junction of the two arms, on a vertical axis comparisons could be made either on the bolometer for the intensity of the radiations or on the photometer for the light intensity. The photometer used was of the Lummer-Brodhun type; the light with which the standard was compared was an incandescent lamp burning under a current of low intensity.

Previous results show that by burning a lamp in this manner its intensity could be kept constant for a very long period.

The general scheme of the apparatus is shown by Fig. 1. A is a circular plate of marble upon which the platinum strip, S, is mounted. A is so made that it turns about an axis passing through its center. The platinum, S, is connected with copper electrodes, which are connected with the battery, B. R is a variable resistance. On the one arm of the bench is the box, O, which contains the bolometer, which is connected on a battery circuit with the galvanometer, G.

FIGURE 2

Between the light source and the bolometer is placed the absorption cell C. This cell is supported on a moveable screen so that it may be carried out of the path of the ray when it is desired to allow the entire radiation to fall upon the bolometer. On the other arm of the bench P and L represent respectively the photometer and the lamp against which the standard was compared.

The bolometer was made in the following manner: A platinum plate is placed between two silver plates of some ten times its own thickness; the plates are then passed through rollers, the distance between which is constantly decreasing. As the silver plates become thin they are strengthened by being placed between copper plates and the rolling continued until the platinum is of the required thickness. In this manner a coherent piece of platinum as thin as 1-3,000 millimeters may be obtained. For practical working, however, a thickness of about three times this amount was more satisfactory. The thickness of those used in the experiment was 1-1,200 millimeters. When rolled to this thickness the silver adheres firmly to the platinum and serves as a vehicle for handling it in a manner that would be otherwise impossible. The silver sheet is then mounted on glass with Canada balsam and cut on the dividing engine in the form shown in Fig. 2. The twelve strips are each 1 millimeter wide, 1.25 millimeters apart and 3.2 centimeters long. The plate after being cut in this form is mounted on a frame of slate, the extremities being soldered to copper electrodes.

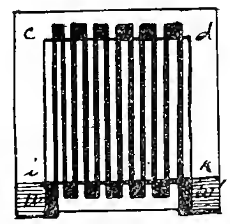

FIGURE 3

Fig. III shows the manner in which the mounting is done; c, d, k, i is the frame of slate, w and w' the copper electrodes to which the extremities of strips are soldered. After the mounting has been done the silver is removed by immersing in nitric acid.

The plate is removed from the glass by chloroform and fastened to the frame by means of resin dissolved in ether. To protect the extremities of the strips from the action of the acid they are covered with Japan varnish.

The surface of the platinum is blackened in order that it may absorb all rays received upon it. The blackening was done by means of platin black, thrown down by electrolysis, in a weak solution of platin chlorid and hydrochloric acid.

Two bolometers prepared as above described were placed one behind the other, so that the strips of one covered the spaces of the other, thus forming a nearly continuous surface on which the radiations were received.

The two pairs of bolometers were connected so that they formed the four arms of a Wheatstone bridge. The radiations fell upon the two opposite arms of the bridge.

The bolometers mounted in the form for the use are shown in Fig. 4. The two pairs are mounted in the hard rubber standards, h and h'. The radiations fell upon those in h. The openings, S, S' allow air to circulate freely through the apparatus. The plate g is of copper, blackened so that it will absorb all rays which fall upon it and serves as a screen to protect the bolometers mounted in h'.

The absorption cell consisted of a ring of glass with sides formed of parallel quartz plates. The quartz plates were 1 millimeter thick and 2 centimeters distant from each other. The cell was filled with pure water.

The temperature of the glowing platinum was so regulated that the total radiation which fell upon the bolometer was to that which passed through the absorption cell in the ratio of 10 to 1.

From a consideration of the curve of the intensity of radiations it is clear that this could be the case only when the temperature of the radiating source remained constant.

The amounts of the radiations were measured by the galvanometer deflections. Since it was impractical to work with deflections one of which was ten times as great as the other, the deflections were made equal. For this three different methods were used. The first was to shunt the galvanometer so that only 1-10 of the current passed through when the total radiations were received.

The second was by changing the resistances of the entire circuit so that their values were in the ratio of 10 to 1 for the total and partial radiations. This method was practi-

cal for relative, but not for absolute, measurements.

The third method consisted in changing the distances of the bolometer from the radiating source so that the distance for the total radiations was to that of the partial radiation in the ratio of the square root of 10 to 1.

At a fixed distance before the glowing platinum a diaphragm of exactly 1 square centimeter area was placed; the light which passed through this diaphragm was taken as the unit.

During the experiments the temperature of all parts of the apparatus, whose temperature change could affect the results, was kept constant by being enclosed in hollow-walled cases through which water was allowed to flow.

In order to reproduce this light unit it is necessary to measure accurately the size of the diaphragm and the thickness of the absorption cell, since these are the sources of error which most affect the results. Another but very small inaccuracy is introduced by a change in the thickness of the black on the bolometer. It was found that a change of 50 per cent in the thickness of this black gave a change of 2 per cent in the light unit. This, however, is small when we consider that the process of blacking is

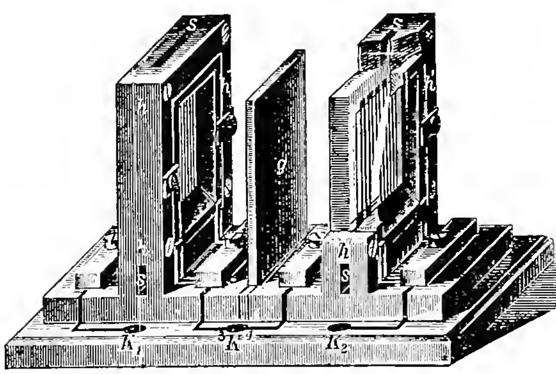

FIGURE 4—A Two-pair Set of Bolometers—From "Zeitschrift fur Instrumentenkunde," March, 1892.

based upon conditions quite readily reproduced, so that the errors in the thickness of the black may be made very small.

A series of observations made with different bolometers prepared in the same way gave results, the greatest variations of which were 0.6 per cent.

The above method shows it to be possible to define a light unit in terms of absolute units. It is, however, only a definition and not an expression for the unit in absolute terms. As the term light involves not only the energy of the vibrating particle but the physiological effect upon the retina it is impossible to express a light unit in absolute terms in the manner that we are able to express a unit of work. It is therefore impossible to express it in terms of C. G. S. system or at present in any known system, as we know that for lights of different colors, the effect produced is not proportional to the energy of the vibrations. The difficulty then lies in the comparison of different lights with a standard. It is well known that one of the greatest difficulties in photometric work is the comparison of lights of different colors. The eomposite thing known as light is, according to the generally accepted theory, made up of the action of a large number of different vibrations. Each vibration producing a different effect upon the eye and the relations of the intensities of the different vibrations determine the nature of the light source. This is shown in the different spectra produced by lights of different nature. We do not know the relative values of different colors in terms of the effect they produce upon the retina. We are then unable to compare the values of the two complex quantities without knowing the relative values of their component parts. In this sense we may say say that a light unit is impossible, and so far actual experience has shown it to be true. Attempts have been made to solve the question by using different standards for different colored lights. This would in a way obviate the difficulty, but would give us no standard unit, but different units without a knowledge of their relative values.

Any complete method of comparing two light sources is one that will take account of all colors which are contained in the sources. This implies the valuation of the different colors in terms of their physiological effect in enabling us to see objects about us. A complete unit is one the component parts of which are known so that the above comparisons can be made. We must therefore conclude that in its broadest sense we are very far from a complete solution of the problem of an absolute light unit, and so far that it is not even shown that in its complete sense such a light unit is possible.

OPERATING ELEVATORS BY DIFFERENTIAL MOTORS.

The Frazer Electric Elevator Company has an exhibition at its office, No. 232 Montgomery street, San Francisco, a model of a new type of high duty passenger elevator that it has under construction and which will soon be in operation in a well-known office building in this city. This elevator presents a marked deviation from all types of elevators now in use in that its motive power consists of two motors run differentially. The principle of operation will be understood by all who are familiar with the principle of the differential chain block, which, it will be remembered, has two different sized pulleys running at the same speed, and by means of which a powerful hoisting effort is obtained. In the Frazer elevator, however, the motors are equipped with pulleys of equal size, but the speed of the motors may be varied, thus giving a hoisting effort through suitable gearing.

A perfect understanding of the working principles the apparatus will be plain from the examination of the model, when it will be seen that the equipment possesses advantages by means of which many objectionable features of ordinary elevator construction are eliminated. Among its principal advantages may be enumerated, in addition to its low first cost, the facts that the motors never are started under load. They are never reversed and they are never stopped until the elevator car is at rest. As the speed is regulated within any limit by varying the resistance in the fild circuit of one or the other of the motors according to whether the car is raised or lowered, the controllr is of the utmost simplicity, consisting only of an ordinary field rheostat.

The Trade.

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

NEW STEAM SPECIALTIES.

The H. N. Cook Belting Company has secured the general Western agency for a number of specialties that are indispensible in high grade steam machinery, and among which may be named the Palmetto self-lubricating packing, which is considered the most durable fibrous packing manufactured. For triple expansion engines it has no equal and it is specially adapted for engines, stop-valves and slip joints, where a high pressure and a high degree of heat exist. The materials entering into its composition are the very best, entirely free from grit and acid and being lubricated with the celebrated Manhattan compound, makes it practically indestructible.

The same concern also handles J. T. Wing & Co.'s high speed graphite metal for dynamos and general high speed engines and machinery bearings.

THE INTERIOR CONDUIT COMPANY AT THE ELECTRICAL EXPOSITION.

The exhibit being made by the Interior Conduit and Insulation Company at the National Electrical Exposition in New York City, is destined to be of great interest because of the novelties that will there be brought out and explained. The Lundell dynamo and motor equipments will again attest their excellence in widely diversified uses as the company will exhibit, for instance a large printing press in operation run by a direct connected Lundell motor. Special emery wheel grinder sets, buffing sets and organ blowing outfits will also be shown in practical operation, as will also an enormous illuminated sign. In addition, the company will exhibit its complete system of plain, brass armored and iron armored insulating conduits, as well as its complete underground conduit system for electric railways.

RECENT DOINGS OF THE WESTINGHOUSE CO.

A great many people who saw and admired the wonderful electric lighting machines furnished by the Westinghouse Electric and Manufacturing Company to the Columbian Exposition Company for the purpose of illuminating the World's Fair, were heard to remark at the time: "What will be done with these machines when the Fair is over?" It may be interesting for these people to learn that the Westinghouse Company recently furnished four of them to the United Electric Light and Power Company of New York City, and they are supplying 40,000 lights to a considerable portion of the metropolis. Several others are installed in the plant of the Brush Electric Light Company at Baltimore, while the rest of them are distributed in different large electric light plants throughout the country.

The Westinghouse recently shipped two of the largest electrical generators for the operation of an electric railway that have ever been turned out anywhere. These two machines were of 1,500 horsepower each, and they were contracted for by the Nassau Electric Railway Company of Brooklyn, N. Y. Last summer the company constructed and delivered to the same railway company three generators of 750 horsepower capacity each, making the total capacity of the electric railway plant 5,250 horsepower, one of the largest in the country. The new generators are of the style known as engine-type, being direct connected to a Cooper Corliss engine running at a speed of 75 r. p. m.

That the product of the Westinghouse Company is of world-wide demand has again been demonstrated recently by the company receiving orders to equip an electric railway in the Isle of Man, a little island near the coast of Ireland, which has been made famous by Hall Caine, the great novelist; another order for electric railway apparatus for the city of Coventry, England, and a third for Capetown, South Africa. The company is also about to ship an order for electric railway apparatus to Bangko, Siam, India.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

We can't have too much light—the more the better for our morals and esthetics.—Long Beach (Cal.) Breaker.

Electricians and progressive men in the towns of the San Joaquin and Sacramento valleys are watching with considerable interest the bill recently introduced by Representative Bowers in Congress to amend the act of March, 1891, granting a right-of-way upon public lands for reservoirs and canal purposes. The reason for this interest is said to be that the amendment is a measure demanded by the development of present conditions, or, more correctly, by the advancement of science in the application of electricity to manufacturing and agricultural enterprises. These men are mostly interested in the cities along the eastern side of the San Joaquin valley and the northern and eastern districts of the Sacramento. Other districts, notably Yolo county and the region around the lakes of Lake county are also watching the progress of this measure. It is held by the interested parties that the amendment will cause a revolution in manufacturing industries, and even in agricultural operations in the great valleys of California, as under present conditions the long stretches of government land and government reservations in the Sierras form an impassable barrier between the sources of power in the mountains and places where it may be utilized for the benefit of the people.—San Francisco Call.

There is nothing at which to be surprised in the announcement that Roentgen's ray is not new. Few discoveries are. It will be remembered that when Columbus thought he had found a continent he had merely dug up an old chestnut that Norsmen had been familiar with centuries before. Our best poets but pipe the lays of antiquity. The freshest jokes are only the withered fruitage of Eden. The most alluring and novel forms of crime were worn out by the ancients. Somebody had the nerve to patent a telephone, and was thereupon abundantly informed that it had been regarded as a household necessity among the Chinese before Confucius. Roentgen seems, like the rest, not to have been exploiting fresh fields, but merely to have lacked the modesty that so effectually prevented hundreds of scientists who knew all he did from imparting some small measure of it to the public. If these scientists are withholding other valuable information—and doubtless time will demonstrate that they are—now is the opportunity to spring it while the popular mind is in a receptive mood.—San Francisco Examiner.

Enemy of the fender,
Foe of the transfer,
Terror of the small boy
Who nips the pasteboard
And makes it, to your woe,
A thing of barter—
Otherwise, Sir Vining, hail!
Once more a pleasant greeting,
Again the loan of your eye
(If it can be unglued
From the elusive nickel);
'Tis said your heart
Is like to break
Under a load of grief
Produced by words unkindly,
And that you cuss amain;
So we, to ease your pang
Pipe but a gentle note.
Beware a broken heart.
If yours be rent to bits
A cathode ray applied
Would show your person
Chockful and paralyzed
With marble-dust.
Hence you must try to smile
E'en though a fare
May now and then escape you.
Think little of traducers,
But of the fun you have
With fenderless and fearsome car
To chase the citizen
And often catch him;
The boon of watching patrons
Hanging aswing from straps,
Elbowed by conductors,
Trodden as to corns,
And sassed if they protest.
The blithesme glee is yours
To stop our transfers,
Gobble our streets,
And tell them who object
To go to, straightway.
Why sure you have a liberal share
Of earthly joy,
And no kick coming,
Even when forced to fib
We know 'tis simply Collis
Fibbing vicariously.
So brace up, Vining.
Be gay and give your critics
That which is sometimes called
By vulgar folk, the merry ha ha.

—San Francisco Examiner.

Electrical power is only in its infancy. When a network of wires takes cheap power into every remote corner of Mariposa county, the development of gold quartz-mining in this district will astonish the civilized world.—Mariposa (Cal.) Gazette.

Kingman will yet be the center of one of the greatest mining sections of the United States, and projected electric lines will be the means of making it one of the largest and most prosperous cities in the territory. As soon as the projectors of the new company have been consulted with we will give an outline of the contemplated work and its great advantages to Mohave county at large.—Kingman (Ariz.) Miner.

Reports of the Month.

Personal

Mr. C. A. Coffin, President of the General Electric Co., has been paying a hurried visit to the Pacific Coast.

M. A. L. Brayton, Secretary and Treasurer of the Pelton Water Wheel Co., is on a business trip to Honolulu, H. I.

Mr. E. Peckham, President of the Peckham Motor Truck and Wheel Co., has been spending several weeks in Los Angeles, accompanied by his wife.

Mr. Geo. A. Steel, President and Manager of the Westside Electric Railway Co. of Portland, Or., has returned home, after several weeks' sojourn in California.

Mr. Robert H. Postlethwaith, late electrical engineer of the New Zealand Engineering and Electrical Co. of Dunedi, N. Z., has located at Carrville, Trinity Center, Cal., temporarily.

Mr. T. C. Martin, Past President of the American Institute of Electrical Engineer and editor of the "Electrical Engineer," has been appointed representative of the Institute to take part in celebrating the jubilee of the professorship of the Right Honourable Lord Kelvin in Glagow on June 15th and 16th.

Mr. S. Mine, Electrician to the Department of Communications, together with Messrs. Y. Wadachi and R. Nakayama, Engineers to the Department of Communications, are at present in San Francisco, but will shortly leave for a tour of America and Europe for the purpose of studying the various applications of celectricity. Mr. Mine is restricting his inquiries to electric railways and the electric transmission, while the other gentlemen will devote their time to telephony and telegraphy.

COMMUNICATION.

Stockton, Cal.—The new Gamewell Fire Alarm system now being installed is to be operated from Storage battery.

Phoenix, Ariz.—The Council is considering a proposition from the Gamewell Fire Alarm Telegraph Co., for maintaining the Fire alarm service.

San Bernardino, Cal.—Chas. D. White has resigned the local managership of the Sunset Telephone & Telegraph Co., to resume his electrical construction and supply business, and Chas. D. Burnell has been appointed to the vacancy.

Oakland, Cal.—An ordinance has been introduced in which a license of $1 per month is imposed upon telephones with "nickel in the slot" telephones on a plane with the nickel in the slot machines used as games of chance.

Portland, Or—The Columbia Telephone & Telegraph Co., has been popularizing its system by giving "Telephone Concerts" in which musicians in various cities along the line of the Willamette Valley Telephone Company participate. The concerts are a great success.

LITIGATION.

Portland, Or.—A jury in the case of W. T. Perham vs. the Portland General Electric Co. has rendered a verdict for $4,500 to the plaintiff for the death of M. C. Perham, a carpenter employed in the repair of a bridge over which 5,000-volt circuits of the defendant were run and who was killed by contact therewith on September 27th, 1893. The action was by Messrs. Reed & Hogue, attorneys, begun on the ground of alleged negligence on the part of the defendant corporation in maintaining high potential wires in a position where workmen

on top of the bridge would be obliged to come in contact with them, in failing to sufficiently insulate the wires and in not notifying the workmen that current would be turned on when the Company knew the men were at work on the bridge. The defense set up the claim of the impracticability of insulating currents of such high voltage as to make contact with the wires safe, together with negligence on the part of the decedent's employer and contributing negligence on the part of decedent. In delivering his charge to the jury upon the question of negligence and contributory negligence, the Judge said: "Some question may be raised about what degree of negligence or what degree of care may be considered as a caust of action, or as exemption from liability. On that subject I instruct you that care or diligence are relative terms; they are not absolute terms, but they are controlled and con escape the consequences of danger must be proportionately action. Where the danger is great the care and diligence to escape the consequences of of danger must be proportionately great. In matters of this sort, where people are dealing with electricity, one of the most subtle, powerful and wonderful agencies known to man, an agency that is very destructive to human life even when carefully and properly handled and treated, I instruct you in such case as this due care would be the highest care and vigilance of which a man is capable and which the condition of science makes known at the time, and that is the degree of care which was demanded of this company, to so conduct itself in regard to its wires on that bridge as that the diligence and care should be proportionate to the danger which there existed." The case has been appealed to the Supreme Court.

INCORPORATION

Oakland, Cal.—The Electric Specialties Company incorporated by A. C. Robbins, Chas. P. Visher, G. F. Burtchaell, Dan'l Crowley and D. F. Jones.

San Francisco, Cal.—The Edison Light and Power Company and the San Francisco Gas Light Company have consolidated and a new corporation is to be formed with a nominal capital of probably $15,000,000.

Los Angeles, Cal.—The San Mateo street and Santa Fe avenue Street Car Company have elected a new directory consisting of Abbott Kinney, President; John D. Pope, D. L. Graves, C. S. Day and C. A. Sumner, Secretary.

Santa Barbara, Cal.—The Santa Barbara Consolidated Electric Company has been re-organized with a capital stock of $500,000. The officers are C. W. D. Miller, president; A. Hope-Deog, vice-president; H. S. Luster, secretary and treasurer.

City of Mexico.—Unconfirmed statements are being made that the electric light plant of the Indianilla race course had been passed into the hands of strong company of United States capitalists and incorporated.

Redwood City, Cal.—Redwood City Electric Light Company. Incorporators and directors: Chas Joslyn, Geo. C. Ross, Geo. H. Rice, Robert Brown and L. P. Behrens. Objects: To succeed to the interest of the Redwood City Electric Company.

Salt Lake City, Utah.—Salt Lake and Ogden Railway Company, capital $800,000. Objects, to build and operate 40 miles of railroad between Salt Lake City and Ogden. Directors: C. K. Bannister and E. M. Allison Jr. of Ogden; E. W. Duncan, J. S. Critchlow and Causten Brown, Jr., of Salt Lake. It is stated that the Pioneer Power Company of Ogden is really at the head of the enterprise.

TRANSMISSION.

Bingham, Utah.—The Dalton & Lark Company proposes to operate its mining plant by electric power.

Bakersfield, Cal.—The contract for the installation of the transmission plant of the Power Development Co. has been awarded to the General Electric Co.

Grass Valley, Cal.—The Fortuna mines, at present using steam power, will shortly adopt water power or install an electric transmission plant.

Spokane, Wash.—The Le Roi Mining and Smelting Co. has issued specifications for a 450 h. p. air compressor driven by twin compound Corliss engines.

Nevada City, Cal.—The Stanley Electric and Manufacturing Co. have been given orders for one 120 k. w. two-phase Stanley motor for use in the Gold Hill mine.

Hanford, Cal.—The Keweah Irrigation and Power Co. is at present paying more attention to irrigation than to the development of its electric power projects.

San Diego, Cal.—Judge Puterbaugh has filed a claim of 50,000 inches of water in the San Luis Rey River, which he proposes to utilize for electrical transmission purposes.

Antioch, Cal.—The Empire Coal Co. Belshaw mine has just installed a 2½ h.p. Westinghouse multipolar 125 volt dynamo for operating lights in the Empire coal mine, the transmission being 3000 feet.

Angels, Cal.—The new company that has secured control of the Sheep Ranch mine is breaking ground on San Antone Creek for an electric transmission plant to operate the mine.

Sonora, Cal.—The General Electric Co. is installing a three-phase induction motor for operating the hoist at the Rawhide mine. The Tolumne Electric Light and Power Co. is now in regular operation.

Merced, Cal.—I. H. Jacobs of San Francisco, owner of the water power of Merced Falls, has been looking over the prospect of transmitting electric power to this place, but has reached no conclusion as yet.

Pomona, Cal.—Single phase synchronous motors are being used here on the single phase circuits of the San Antonio Light & Power Co. The head of water at the power house of the company has been increased 50 feet.

As an inducement to come to Riverside, the City Trustees have offered the Connecticut Shoe Factory electric power at the rate af $1 per h. p. per month for day power for the first year, and after that $3.

Mariposa, Cal.—H. H. Clark, General Manager of the Bend Power Co., has requested mine owners and other probable power consumers to state their requirements so that adequate machinery may be installed at the outset.

Yreka, Cal.—Work on the Big French Creek ledge has been suspended, owing to the cost of water power, and the mining company proposes to install a transmission plant to be operated by water it owns, the power of which is unavailable at present.

Marysville, Cal.—W. W. Waggoner of Nevada City has located all the available water at the narrows of the Yuba River, and proposes to bring about its utilization in irrigation and electric power transmission in Smartsville, Marysville and Wheatland.

Ione, Cal.—The Blue Lakes Water Co. has about perfected arrangements for its transmission plant which will be located at Tripps Mill. It is claimed that 20,000 h.p. is available, as much of which as required will be transmitted to the mines in the vicinity and Stockton.

ILLUMINATION.

Mendocino City, Cal.—An electric light plant is talked of.

Spokane, Wash.—Gas is to supersede electric light in the Court House.

Murphys, Cal.—The capacity of the electric light plant is to be increased.

Petaluma, Cal.—A cold storage and ice plant has been added to the electric light works.

Crescent City, Cal.—A. A. Barneburg has applied for a 20 year electric light franchise.

Ben Lomond, Cal.—T. L. Bell is to install an isolated plant for lighting his residence.

Zamora, Mexico.—Francisco Celoso Garcia is endeavoring to erect an electric lighting plant here.

Sanger, Cal.—The Sanger Lumber Co. is installing a 25 light arc dynamo at its mountain mills.

Palo Alto, Cal.—The incandescent circuits of the Redwood City Electric Co. have reached this place.

Reding, Cal.—A 1000 light Westinghouse alternator has been added to the plant of the Redding Electric Light Co.

Santa Ana, Cal.—E. C. Sharp of Riverside has been appointed consulting engineer for the proposed municipal plant.

Berkeley, Cal.—The grounds of the University of California are now lighted by electricity from the University plant.

Mercur, Utah.—The plant of the Mercur Electric Light & Power Co., is about ready to begin operations. Geo. Brown is Manager.

Fresno, Cal.—The San Joaquin County hospital will be lighted with incandescent lamps operated by the San Joaquin Electric Co.

Grass Valley, Cal.—The Nevada County Electric Power Co., has bought the plant and interests of the Grass Valley Electric Lighting Co.

Hermosillo, Mexico.—It is stated that a new company in which Governor Corral is interested will soon establish an electric light plant here.

Tucson, Ariz.—The Tucson Electric Light Co. is at present operating 1,800 incandescents and 18 arc lamps. Wood fuel is used, costing from $15 to $18 per day.

Nevada City, Cal.—The City Trustees have accepted the proposition of the Nevada County Electric Power Co. to furnish the city 55 all night street incandescant lamps for $100 per month.

Long Beach, Cal.—The new 125 h.p. Ball tandel compound engine is now in operation at the electric light plant and service is being rendered for about 1400 lights in Long Beach, San Pedro and Wilmington.

Grass Valley, Cal.—The Nevada County Electric Power Company has purchased the plant, business and good will of the Grass Valley Electric Light Company from John Glasson, its owner. This will cause the abandoning of the old plant on Deer Creek, as the service will hereafter be rendered from the light and power transmission circuits (Stanley system) of the Nevada County Company.

Mazatlan, Mexico.—The local press states that the Mazatlan Gas Co. charges exorbitant rates as a result of which the municipality has become indebted to it to the extent of $100,000 on which the company charges 12 per cent. interest. The residents of Mazatlan have, therefore, petioned the governor to award the public lighting contract to an electric light company, that has just started business in Mazatlan, or to call for tenders for the service.

Los Angeles, Cal.—The West End Electric Lighting Co., which was installed by E. E. Peck just outside the city limits but which has now become incorporated within the city owing to the recent extension of the city limits, has secured the

City of Mexico, Mexico.—The isolated plant for lighting the h.p. Corliss-Fishkill engines, two 75 h.p. Bass Corliss boilers National Palace is now in operation. It consists of two 60 and one 37.5 kw. Westinghouse multipolar generator. The incandescent lamps used are of 8 cp., and the engines also operate the machinery in the stamp engraving department. The plant which was installed by Mr. J. Sternefeld, chief engineer for the engineering firm of G & O. Braniff & Co., was inaugurated by President Diaz with much ceremony.

MISCELLANEOUS.

Berkeley, Cal.—An ordinance has been enacted prohibiting the stretching of electric wires, and the erection and maintenance of pole lines in this town, "except by and with the consent of the Board of Trustees, and under such rules and regulations as may hereafter be prescribed."

Nevada City, Cal.—Charles L. Ferris, a native of Colorado, and 47 years of age, was instantly killed at Providence mine on March 26th by an electric shock. Ferris was a lineman in the employ of the Electrical Construction & Repair Company, and in starting to descend from a pole one of his climbers slipped and, in throwing out his arms to recover himself, he bridged a 2,000-volt circuit.

Sacramento, Cal.—A severe thunderstorm visited this section on March 27th, when lightning struck the transmission circuits of the Sacramento Electric Power & Lighting Company, entering the Folsom power-house and necessitating the stoppage of the plant for four hours. The lightning arresters designed for the protection of the system had not been erected by the contractors, owing to the infrequency of lightning in this vicinity, and to this inattention is attributed the damage wrought. Several poles on Twenty-eighth street in Sacramento were splintered, but no further material damage ensued.

Anaconda, Mont.—One of the largest electro-deposition plants in the world has just been erected here in the works of the Anaconda Copper Company. It consists of two triple-expansion vertical engines, built by the Union Iron Works of San Francisco, to each of which is directly connected two 270 kw. special Westinghouse generators. The engines are run condensing at a boiler pressure of 150 pounds at 150 r. p. m. The generators are 14 pole machines, and each delivers 3,600 amperes at 75 volts, the current being taken from each machine by 98 carbon brushes. The plant is used for the electrolytic refining of copper.

San Francisco, Cal.—M. A. Rothschild, President of the Gerlach Wave Motor Company, states that the wave motor described in the Journal for January is in running order, and is developing as high as 180 h. p. The company, however, is not satisfied with the location of the apparatus, which is in a bay at Capitola, rather than on the ocean beach, and until a better location can be secured nothing will be done towards utilizing the power. The directors have not yet determined upon the means by which the power will be utilized.——The Board of Supervisors has passed an ordinance amendatory of section 115 of order No. 2,927, requiring that wires used for electric or other purposes, when over six in number and bunched, shall be enclosed in a metal tube within buildings, and that main service switches located at or convenient to the main entrances of buildings shall be placed in all premises using electric light, heat or power.

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A Mexican Transmission Plant

BY GEORGE J. HENRY, JR.

In the State of Hidalgo in Mexico, there is now being erected one of the most modern and thoroughly equipped hydraulic electric power stations for the long distance transmission of power that modern engineering genius can devise. The excessively high price of fuel in the mining district to which power is to be furnished, and the large quantities of power necessary for pumping and to drive the old Chilian mills, will probably make the scheme so fine a financial investment as to give hydraulic electric transmission a great impetus throughout Mexico. In fact, the outcome of this project is now being watched by the engineering profession of the whole Republic.

The Cia. Anonima de Transmission Electrica de Potencia has located the scene of its operations in the State of Hidalgo, about 100 miles north of the City of Mexico. The water is taken from the Arroyo de Regla, a mountain stream having a minimum supply of 1500 cubic feet per minute. A natural rock dam at a favorable point in the canyon, impounds the water sufficiently to admit of its being diverted by a cut through the bluff into a canal which follows mostly the contour of the mountain a distance of 1½ miles, a work which involved the cutting of seven tunnels, aggregating a total length of 1200 feet, through solid rock of hard volcanic formation.

Situated some 17 miles from the mining country is located the power house which is illustrated herewith. The site chosen is at the foot of a very precipitous gorge over 1000 feet deep and reached only by trail. From the terminus of the canal the water is carried to the power station through 1700 feet of 30-inch pipe, which affords a means of easily obtaining a head of 800 feet by running a tunnel, which, though short, proved very expensive to construct, because of its running through the very hardest of volcanic rock. The pipe line discharges into a receiver which is 40 inches in diameter by 75 feet long and made of three-quarters-inch sheet steel. The receiver was tested to 700 pounds hydrostatic pressure and weighs upwards of 50,000 pounds. Hydraulic valves and cylinders operate gates for each of the water wheels used and everything is installed with a view to the most simple and easy operation. The power station consists of two 24-inch Pelton exciter wheels running at 1700 revolutions per minute, and five Pelton water wheels, each 43 inches in diameter, and having a capacity of 600 horse-power. Directly connected to each of four of these 43-inch wheels is a 12-pole, 300 kilowatt, 500 volt, 3-phase General Electric generator, running at a speed of 600 revolutions per minute and delivering current to a bank of six transformers, a seventh being held in reserve, two transformers being included in parallel in each leg of the 3-phase circuit. Before reaching the transformers, however, the 500-volt current is taken through a very handsome and complete switchboard, where it is equalized on a set of three buss bars.

POWER HOUSE OF THE HIDALGO TRANSMISSION PLANT

The transformers deliver current to the transmission

lines at 10,000 volts, after having gone through the high potential switchboard ammeters and break switches. The line consists of three 0000 B. & S. copper wires, supported on double petticoat porcelain insulators. There are to be three step-down transformer stations located at the most convenient points along the line, which will give low potential current to the induction motors to run the pumps and mills. All transformers are of the air blast type.

This transmission plant is to supply power to the mines of the Rio del Monte Company, one of the most extensive mining organizations in the world, employing upwards of 8000 men. The power is to be used for operating mining machinery, such as stamp mills, crushers, pumps, hoists, ventilators, etc., etc. The mines of this company—said to be the richest in Mexico—are located within a radius of 20 miles, the maximum distance of power transmission being 23 miles, and the mean distance about 18 miles. Various other mines in the vicinity will also be supplied with power from this station, and the city of Pachuca also furnished with light. A market for the entire power of the plant being thus afforded at highly remunerative rates, the financial success of the enterprise is assured; in fact, it is claimed that the entire outlay, some three hundred thousand dollars, will be returned to the company in two years' time, by the saving effected in fuel heretofore required in carrying on their various operations.

Considering the magnitude of the work, the great water pressure, the variety and extent of machinery to be operated, as well as the difficulties attending the transportation and erection of such massive machinery in a mountainous and almost inaccessible region, this may be regarded altogether one of the most remarkable electric power installations so far made in any part of the world, with the single exception of the 35-mile transmission plant of the San Joaquin Electric Company of Fresno, Cal.

Mining

THE NUCLEUS OF A GREAT TRANSMISSION PLANT.

The Utica Mining Company of Angels Camp, Calaveras County, annually produces between five and six million dollars worth of gold, which is the largest output of any of the gold mines in California, and at present all the power consumed in the operation of the mine, except that for lighting, is obtained from steam, which is very expensive owing to the high price of fuel. It was therefore deemed advisable to derive experience in the application of electricity for lighting and power purposes before making the expenditures that would be necessary for the installation of a plant of such magnitude as would satisfy the company's requirements. Accordingly in January, 1895, the small plant now described for the first time was erected, first in order to secure satisfactory lighting at the most reasonable cost, and second, that greater familiarity with electricity might be obtained not only by the management, but also by the miners themselves. Though this original plant is simple in the extreme it has fulfilled its purposes and will shortly be superseded by one of the largest mining installations in the world.

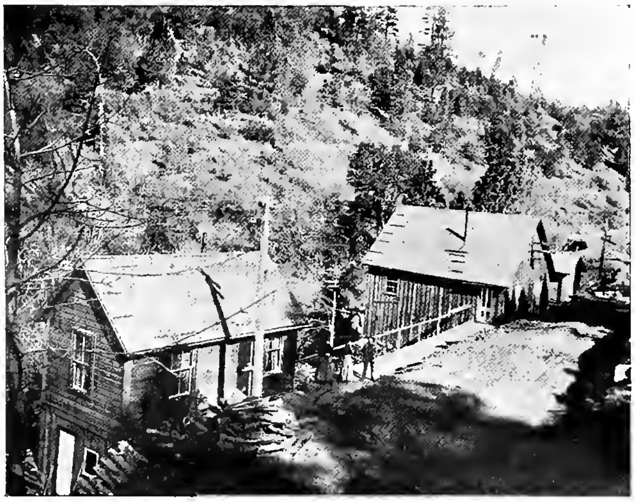

FIGURE 1—ORIGINAL POWER HOUSE OF THE UTICA MINING CO.

FIGURE 2—INTERIOR OF POWER HOUSE OF THE UTICA MINING CO

The company owns the water power of 2000 miners inches of water secured from which is obtained a fall of 570 feet in 1750 feet of pipe line. The present electrical plant uses about 150 inches of water of the 3000 horse-power available. The power derived from a 6-foot tangential Dodd wheel is belted to a 1,500-light 2,500-volt Westinghouse alternator, whence the current is carried over a circuit of 1 B. & S., guage, bare copper wire to the mine situated about 1,000 feet below the plant, where it is used for lighting purposes, there being 25 alternating current constant potential arc lamps and 1,250 incandescents. The exciter is driven by a separate 12-inch Dodd wheel.

It has been practically decided that during the coming summer the large installation referred to will be undertaken, when 3,000 horse-power will be generated and transmitted to the mine and thereabouts. The length of transmission will be about 8½ miles and the system will consist of 2-phase generation, 3-phase transmission and various distributions. Five hundred horse-power will be utilized in air compression, two 60-stamp mills will require 150 horse-power each, and one, 250 horse-power rotary transformer will generate low potential direct current to be used for power purposes down the shaft. Six 500 horse-power units to operate in parallel or singly, as deemed advisable, will be installed and the transmission will be at 10,000 volts. In addition to the purposes named, two sawmills, together with machine shops, rock breakers, etc., will be operated by electric power. The apparatus used will be that of the Westinghouse Electric & Manufacturing Co., throughout.

Electro-Therapeuty

THE SCIENTIFIC APPLICATION OF ELECTRICITY IN MEDICINE.—III.

BY W. N. SHERMAN, M. D.

Static or Franklinic electricity has become one of the most useful and favorite methods in electro-therapeutics. There has been great mechanical improvement in the various static machines of late years, and it is no longer necessary to employ extra apparatus for charging the machines as the best of them pick up their charge quickly and begin to generate a current at once, and will when properly cared for work nearly every day in the year regardless of the climate.

The Atkinson-Topler static machine, made by the McIntosh Company of Chicago, is the best of any I have used and affords a variety of currents according to the electrodes use. The static induced current is similar to the Faradic current and may be given without removing the clothing, as may also the static bath and breeze, the direct and indirect spark, the localized spray and static insulation.

These various methods of application may be used as indicated in each particular disease or ailment and afford a pleasant and effectual method of treatment in many diseases. Owing to its high electro motive force (60,000 to 100,000 volts at ordinary speed and giving a one-inch spark) the static current readily overcomes the resistance of clothing skin, and reaches the nerve centers in a remarkable manner. Any good static machine may be used in a very satisfactory manner for producing Roentgen or "X" rays, and when connected to a Crooke's tube a three or four-inch spark is usually sufficient, but the tube should be of higher vacuum than when used with the induction coil. Galvanic, static and Faradic electricity in the order named are of most frequent use in electro-therapeutics. The sinusoidal current is yet new, but may in time prove as efficient as any of the other forms.

I shall conclude by mentioning a few other applications of electricity used mostly in surgical work and for motor and illuminating purposes, the source of the current with few exceptions being from two or more storage cells. The surgical uses of the continuous or galvanic current properly come under four divisions, viz: chemical, physical, illuminating and motor. Under the first head should be placed electrolysis, as practiced in the removal of hair, the destruction of facial blemishes, such as naevi or wine marks, erectile tumors, aneurism, goitre, piles, strictures, etc. For such operations from six to eight volts from small primary cells, and from three to five milliamperes of current are used.

For cautery purposes, such as the heating of small platinum knives, wire, etc., a current of great quantity (75 to 100 amperes) is used with a small potential of from 4 to 6 volts supplied by secondary or storage cells. The same current is used for small incandescent electric lights for the examination of the internal organs such as the bladder, the stomach, and other cavities. These methods of introducing small lights into the human body afford an effectual and convenient method of diagnosis in many diseased conditions. In the throat, nasal and post nasal cavities, these electric lamps are made so as to fit into the same cautery handle as is done with the small cautery knives used in nose and throat work. In the amputation of certain soft parts, such as the tongue, the hot platinum wire is far superior to other methods, as it is clean, and affords an almost bloodless means of operating. This method is often used for small amputations of vascular organs, tumors, and soft growths, leaving as it does a clean, bloodless stump which heals quickly. With energy from the same source as that used for cautery and illuminating purposes, one is enabled to run a surgical engine with flexible cable and drills for removing exostoses in the nasal cavities and elsewhere. It is convenient for running the static machine when connected by belt to a small motor, also for winding bandages in the operating room, for rotating a centrifuge and for other mechanical work.

A word about electric belts. Physicians who understand electricity do not use or recommend them because they are worthless. I have never seen an electric belt that would indicate one milliampere on a short circuit. Then let me ask what effect would such a belt have on the highly resisting surface of the human body?

ERRATA.—Through inadvertance, the authorship of Part II. of the serial that has recently been published on "The Scientific Application of Electricity in Medicine" was ascribed to "W. N. Williams, M. D.," whereas the article should be credited to W. N. Sherman, M. D.," to whom sincere apologies are extended.

A MONOCYCLIC DISTRIBUTION PLANT.

One of the most interesting modern stations in this country, and the first, perhaps, which has a larger motor load than a lighting load, is that at Middletown, Ohio, operated

FIGURE 1—GENERATING STATION, MIDDLETOWN, O.

by the Middletown Electric Light and Power Company.

It is now some four months since Mr. E. H. McKnight, president and general manager, determined on an increase in his station, which up to that time had operated on a small scale only. The conditions with which he was confronted showed the necessity for a system of distribution which would allow him to cope with a large demand for current for motor service during the day and a similarly large one for lighting after dark. As best satisfying these conditions, Mr. McKnight selected the Monocyclic system of the General Electric Company.

The power house is large and well ventilated and is situated near the center of the city in an ideal location for an electric station. It fronts on the Cleveland and Cincinnati Canal, while immediately behind it are the tracks of the M. & C. Railroad. Water for the station is taken from the canal in front and the necessary coal is shoveled directly into the bins from the cars standing on the tracks behind.

The steam equipment consists of two Brownell and Dayton boilers, furnishing steam to one 250 h. p. Russell engine and one 100 h. p. Ball engine. The first runs at 164 revolutions and drives from a countershaft the new monocyclic generator and two T. H. 75 light arc dynamos; the

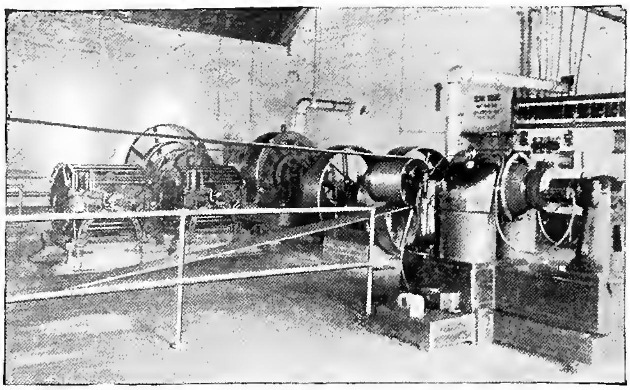

FIGURE 2—INTERIOR GENERATING STATION, MIDDLETOWN. O.

latter runs at 285 revolutions and drives a D-62 T. H. bipolar direct current low voltage machine. The monocyclic generator is a standard 12 pole machine, running at 600 revolutions. It is rated at 150 k. w. at 1040 volts, and is excited by a 1½ k. w. exciter. The D-62 furnishes current for direct current motors scattered throughout the city. The arc machines operate lights in the streets, while the monocycle is wired for about 180 horse power in motors and 2000 lights. If all the lights and motors were operated at the same time the total amount of energy required from this generator would be about double its capacity and its power to cope with the conditions illustrates forcibly the advantages of the monocyclic system. During the day the lights burning are comparatively few, while the motor load is at its maximum. This condition is reversed after dark, when the motor load drops off and the lighting load rises in turn. The generator, which runs 23 hours per day, is worked continuously at its highest efficiency and satisfactorily fulfils its double duty without sparking or noticeable heating.

With service of this severity, deterioration in the performance of the machine would naturally be expected. Yet, it has been running for about three months under these onerous conditions without a minute of lost time from any cause whatsoever.

The regulation of the machine is noteworthy, the voltage remaining almost absolutely constant. The lights at a large factory, about a mile away, and those throughout the the city, burn with equal brilliancy, and the throwing on or off of the motor load is accomplished without flickering or variation of the intensity of the light. In fact, the presence of the motor load is usually only determined by examination of the ammeter. This perfection of regulation is attained by placing the stationary shunt of the alternator in a certain position in the morning, and leaving it thus during the day, while the induction motor load dominates. At night when the lighting load is the heavier, the only change necessary is the advancing of the stationary shunt about one inch. No care beyond this is needed to maintain a constant potential—the machine apparently takes care of itself.

FIGURE 3—MIAMI CYCLE & MANUFACTURING CO.'S PLANT

The most important client of the Middletown station is the Miami Cycle and Manufacturing Company, whose factory is located about one mile distant. It takes current for 180 horse-power in motors; for 800 incandescent lamps, of which 400 are usually in use, and for six arc lamps. The cycle company turns out about 200 wheels a day, and employs from 500 to 600 hands. It manufactures an extremely high grade bicycle, the assistance to this end which electric service renders.

The current is transmitted from the station to the works over two mains and a teasor wire at about 1000 volts, and is reduced to about 115 volts in six 30,000 watt oil-cooled transformers installed in a small house erected in the angle of the L-shaped main building. All the mortors derive their supply of current from these transformers connected to multiple. The lighting circuits are taken off from two 7500 and one 15,000 watt transformers. The primary wires from the station are passed through a station watt meter just before they arrive at the transformers, and thus the consumption of energy in both lightning and motor circuits is measured in one instrument.

The secondaries run from the small sub-station north and

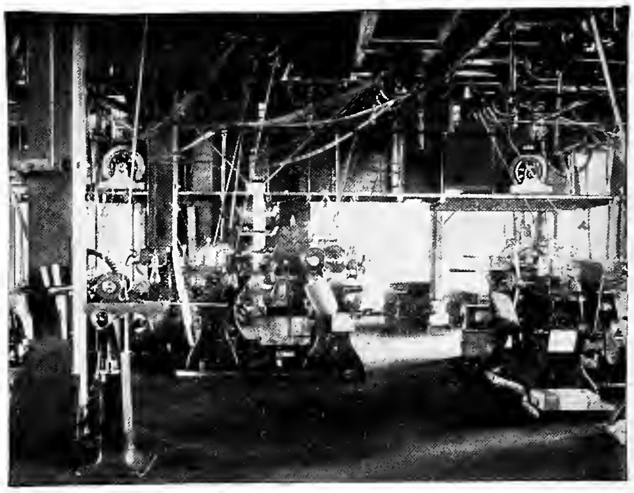

FIGURE 4—CORNER OF MACHINE ROOM, SHOWING INDUCTION MOTORS

south to the motors and lights in the two legs of the L. Those running south operate in the machine shop 3 20 h. p. motors, each belted to a long line of shafting from which run 80 belts. One of these motors is used to drive 15 lathes, 4 sharpers and 6 milling machines; 3 water emery wheels, 1 planer, 1 die sinker, 2 universal grinders, 2 gear cutters, and 2 drill binders. The other two operate 35 screw machines, 1 oil separator, 1 oil pump, and 2 high-pressure blowers, giving air to the forges in the smithy.

The feeders running north supply energy to three 30 h. p. motors, two of 10 h. p. and two of 5 h. p. One of the 10 h. p. motors is in the drill room and runs a shaft from which belts run to 12 large and 3 small drill presses, 2 cone grinders and 4 small milling machines. In addition, it operates 1 band saw, 1 circular saw, and 1 wood turner's lathe in the pattern room adjoining. The other 10 h. p. motor is in the Frame Making Department and drives 3 large punch presses for the manufacture of handle bars, seat posts, etc., 3 large drill presses, 4 small ones, 2 frame assembling tables, 3 small milling machines, 2 emery grinders, 1 swaging machine, 4 stock machines, 2 tooth cutters, and 1 double-polishing lathe.

A large portion of the power which comes into the factory is used in the Polishing Room, where 35 double-polishing lathes run incessantly. Those are operated at present

by two 30 h. p. motors. The remaining 30 h. p. motor in the north section drives a 48-inch exhaust blower, which carries away the dust from the Polishing Room.

Located in the Assemblying Department is a 5 h. p. motor, which operates a freight elevator of 1500 lbs. at 60 feet per minute capacity through the room. When this was put up it was thought that a larger motor would be required to move up and down the occasional heavy loads, but the 5 h. p. motor not only operates the elevator satisfactorily, but also has sufficient power left to drive 5 small drill presses. The other 5 h. p. motor drives a 4 k. w. C. & C. generator used for plating purposes.

All these motors are of the General Electric Induction type, without commutator, collector or moving contracts. They are set up on platforms swung from rafters in the rooms, an arrangement rendered possible by the fact that they require no attention beyond an occasional oiling, and thus occupy no floor space whatsoever.

The introduction of the induction motors into these works was the result of pure conversion. Skeptical at first, the company, willing enough to allow a trial, permitted the installation of a 20 h. p. motor as an experiment.

FIGURE 5—MACHINE ROOM, SHOWING MACHINERY DRIVEN BY MOTORS

It reached the factory in September, 1895, was put into service in the Machine Room and ran the machine for the night shift. The experiment was as severe a test as could well be imagined for a motor. It ran over 300 feet of 3-inch shafting, 172 belts, 5 screw machines and 17 other machines such as drills, lathes, etc. The usual course was to add machine after machine until the motor stopped. One or two would then be thrown off and under an excessive overload which brought it within the reach of breaking down, the motor continued to run for its shift of ten or twelve hours. No accident happened to it during the two months this course of treatment continued. Its missionary work was successful. It was purchased by the cycle company, which ordered eight others at once, to be sent by express. Their factory could not be equipped electrically too soon for them. The constant speed of the machinery has enabled them to turn out a wheel with workmanship of peculiarly high quality, and its success has compelled them to enlarge the works, which are entirely lighted with lamps taking current from the monocyclic generator.

In addition to the load at the Miami Cycle Works, the monocyclic generator supplies current to 500 to 600 lights throughout the town, and 650 incandescents in the Sorg. Opera House. With 50 h. p. in motors and 400 lamps

FIGURE 6—PART OF ASSEMBLING ROOM, SHOWING MOTOR FOR ELEVATOR

burning at the cycles works, and as many in the city, the lights in the Opera House burned brightly and without flickering.

The description of this noteworthy plant, the success of which is due to the able management of Mr. McKnight, may fitly be concluded with his own remark, "In all particulars, it surpassed my most sanguine expectations."

UTILIZING WASTE POWER ON RAILROADS.

A straw which points to the future development of a remarkable source of economy in freight railroad traffic is the utilization of the weight of the freight which is proposed on a new road in Northern Michigan. The road runs from Lake Superior fifteen miles inland to the mines, and in this distance the total grade amounts to a rise of 800 feet. The freight will be almost entirely iron ore, which is brought down in special cars, which are returned empty to the mines. The cars will be run in trains of ten each, each train being supplied with an electric generator, connected with the axles. The grade is such that the loaded cars run by their own weight, and the dynamos generate a current, which is taken off upon a trolley wire and used to haul the empty cars back. It is thought that the difference in weight of the loaded and empty cars will give power enough to overcome all leakage, friction, etc. The engineers are figuring on using the dynamos as motors on the return trip, and thus saving expensive machinery. The experiment will be awaited with interest.

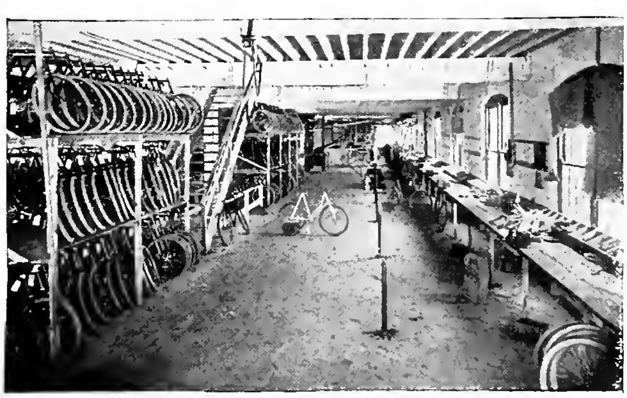

FIGURE 7—ASSEMBLING ROOM

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY
F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

LIGHTNING ARRESTERS IN CALIFORNIA

The history of electric undertakings during the past two years has sufficiently proven the folly of installing overhead electric lines upon the Pacific Coast, and particularly in California, without the use of lightning arresters. The neglect of this means of protecting electric circuits we believe has come partially from a misunderstanding of the conditions of the climate and partially from a lack of understanding of the functions of a lightning arresters. The idea that arresters arrest when the line has been struck is erroneous, for, as an eminent authority has said concerning lightning strokes: "It is rare that an overhead electric line is directly struck by a lightning flash, but when this does actually happen, there is but one remedy; to trust in Providence and repair what is left of the station." Lightning arresters do not, therefore, serve as conductors in the case of a flash striking the wires, but do allow an easy adjustment of potentials upon the line whenever a lightning stroke has occurred anywhere in its neighborhood. A flash of lightning is a discharge between oppositely electrified bodies, which may be two different clouds or a cloud and the earth; in any case the potential of the surrounding atmosphere is reduced to that of the earth, or to zero, and there is a tendency for all bodies in the neighborhood which have been electrified, either directly from the charge of the clouds or by induction at the time of the flash, to discharge themselves. An electric line finds itself at the time of every lightning discharge in its neighborhood in the condition of a charged body at a different potential from that of the earth, and unless we provide some easy path for the charge of the line to be reduced to the potential of the earth, the insulation will be pierced and the charge will find its own path to the ground. On account of the high self-induction of a portion of the machinery of the station the two opposite sides of the line will separately discharge themselves and the dynamo current following the static spark a disastrous short circuit will result unless a lightning arrester is provided for overcoming this difficulty. It is at once seen that even a rare storm and rare flash of lightning may occasion much damage in an electric station because an electric line must discharge itself, nor merely in the unlikely condition of its being struck, but at every time there is an electric discharge in its neighborhood. Simple lightning arresters are not expensive pieces of apparatus nor difficult to care for, whereas, the damage that has been done in California during the past two years to the apparatus of those who have relied upon a traditional immunity from lightning strokes would have paid many times over for a complete equipment of all California stations with efficient lightning arresters.

ECONOMY MUST FIT THE LOAD CURVE

To the engineer familiar with English practice, either through experience or through the knowledge of their literature, it is very striking to find that in the United States comparatively little value has been placed upon experiments made with steam generators, and of no class of steam generating plants has this been truer than in those connected with electric lighting stations.

In England, we find the old Lancashire and Cornish boilers giving good service, and at the same time extensive use is made not only of the "return tubular," but also of the "water tube" boiler, while in the United States no attention has been paid to any type except the "return tubular," unless the type has been patented and extensively advertised by a manufacturing company. In other words, American engineers seem to depend less upon their own experience than upon the claims made by others and upon single sets of experimental trials. In electrical engineering this is not only due to the fact that only a very limited number of engineers have the time and experience necessary for designing a special boiler plant to perform a special service, but also it is due to the fact that the generation of steam in an electrical supply company demands that the particular location of the station should be considered as well as the economy to be achieved. Where the station is placed in the heart of a city, it is not possible to install boilers of unlimited size, nor is it possible to risk accidents from untried systems of construction, and therefore our engineers are in the main to be commended for an extreme conservatism in installing under such circumstances only those types of steam generating apparatus which have been tried and proved entirely reliable and at the same time with the increase of loads and the multiplication of competitive plants as well as the experience that has been gained in high potential transmissions. American engineers are finding a new set of conditions which not only require a restating of the problems of efficiency, but also allow the possibility of individual experimentation.

We are too much disposed to rely upon efficiency tests at full load, while the efficiency of a station depends upon the efficiency at an exceedingly variable load, and if we can develop a boiler plant which shall furnish a pound of steam with a reasonable amount of coal, considering the day as a unit of time, rather than the period of full load, we will solve the problem that now presents itself before electrical engineers of reducing an outrageously extravagant coal consumption that is noticeable in all of our central stations.

It is time for a reaction to set in against high efficiency apparatus, both steam and electric, which is only capable of giving high efficiency at maximum load, and it is time for central station engineers to consider more carefully than they seem to have done in the past, the average efficiency of their central stations' plant. We now point out particularly the boiler plant as a fundamental part of electrical generation, particularly because this part of the plant has been neglected by individual engineers, no matter how carefully it has been investigated by the engineers of special boiler types.

CHEMISTRY IN WATER POWER DEVELOPMENT

One of the most serious of the problems which face the projectors of water power transmissions in California is set by the great fluctuation in the amount of power available at different times of the year. Either only so much machinery must be installed as can be driven at the period of minimum flow of water, great reservoirs for water storage must be provided, or, it will be necessary to obtain some load that will utilize the surplus of power during the periods of maximum flow. Installing the minimum amount of machinery in many cases seriously limits the capacity of the generating plant; to build great reservoirs for water storage will entail an enormous expense and produce interest charges, greatly diminishing the advantage of water power transmission over the production of a similiar amount of power by coal consumption, while it is hardly possible to expect that the users of power will install duplicate steam and electric apparatus in order to obtain the advantage of low power charges during the maximum flow period.

The only feasible plan for using the power during this period of maximum flow seems therefore to be by some manufacture that can be economically carried on in seasons and not through the whole year. Such manufactures may easily be found in the field of electro-chemistry. It is rumored that the proprietors of the plant at Folsom, Cal., are contemplating the installation of a plant for the manufacture of calcium carbide during this period of maximum flow of water and an extension of this principle to many of the processess of electro-chemistry seems to contain the best possible solution of this vexed problem.

At the present time copper refineries are established throughout the United States which do not run throughout the entire year; the production and storage of bleaching salts, of chloride of potash, as well as of calcium carbide, do not seem to present insuperable difficulties, provided the power for their production can be obtained with sufficient cheapness, especially as in many cases the period of the minimum flow of water is only of short duration and the consequent accumulation of stock for the shut-down period will not be much greater than is at present provided for by the copper plants above referred to, by glass manufacturers and by others who are already in successful operation throughout the world. Indeed, we are bound to consider that the field of electro-chemistry is a very important one in the development of electric power throughout California since there is no doubt but that the amount of water power available is far in excess of any possible manufacturing demands for years to come, so far as the simple power used in the factories is concerned, while the cheap production of bleaches, dyes, acids, and other chemicals that must be brought from the East or from abroad, before great manufactories can be established, is of greater importance in the cost of the manufactured product than is the expense of coal simply for driving the machinery, and the successful establishment of many great manufactories west of the Rocky Mountains will surely depend as much upon a cheap supply of these necessary supplies as it will upon the availability of cheap power from long distance transmission.

THE G. E. CO'S ANNUAL REPORT

The fourth annual report issued by the General Electric Company from Schenectady under the date of April 18th will be anxiously examined alike by the friends and foes of the corporation to determine if possible the elements of strength or weakness within this great electrical organization.

The year has been one of many disasters in all fields of business and the common depression has been felt by the General Electric Company, as no doubt it has been felt by its rivals as well. The presence of a clear manufacturing profit upon the business taken for the year shows that the period of illegitimate business speculations has been past forever by electrical manufacturing concerns, and that this can be so is a matter of congratulation not only to those interested in the particular company under consideration but to all financially concerned in electrical enterprises. At the same time the period of past speculation is hard to live down and we find in the report material items of unprofitable investments which cannot be reassuring to the stockholders of the company.

Considering first the income above the expenses of running the company by themselves, we find it placed at $1,388,000, which amounts to a little more than 4 per cent upon the entire capital stock of the company, and while this effectually disposes of the claims which have been made that the company was in a bankrupt condition, the earnings can hardly be said to be satisfactory from the standpoint of an investor who is at all familiar with the expenses of operation of an industrial company, since the amount written off against the factory plant, in order to obtain these balances, does not amount to as much as 1 per cent of their valuation.

Looking now at the company's report, in order to deter-

mine, if possible, its value as a property, we find that almost $14,000,000 of the company's capitalization is not accounted for by any assets, in spite of the fact that the patents and franchises, earning $585,000, are valued at $8,000,000, and the stocks, bonds and notes, earning $421,000, are valued at $12,000,000. To be sure, it is impossible to estimate the actual value of the stock of this company from such a balance sheet, but we can conclude from its perusal at once that the capital which has been involved in the formation of the company does not earn as much as would be expected from ordinary industrial investments, and while the capital stock may be valued at anywhere from 30 to 60, it can hardly be given a higher valuation by the most enthusiastic admirers of the management, while there is no doubt that the condition of the company contains all the elements of a financial disaster and to bring it from its present condition of an unsatisfactory investment into that of its former great favor will require financial ability not hitherto shown by its managers.

There is no doubt but what the General Electric Company will live for many years to come, and that it will partake in the next wave of prosperity that may sweep over the country, but it can never again take the commanding position held from its origin until the crash in 1892, nor will it ever again be enabled to disturb and destroy business as it was accustomed to do in the past.

Passing Comment

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

ARE TELEPHONE COMPANIES COMMON CARRIERS?

An interesting legal point has recently been brought up in a suit entered by the Norwalk Telephone Company against the Central Union Telephone Company, in which the Norwalk Company demanded the right to use the toll lines of the Central Union Company for the transmission of the Norwalk Company's messages, the claim being made that a telephone company is a common carrier and consequently is obliged to transmit messages at a reasonable toll rate, in spite of the fact that they originate on the wires of a competitor. The case is fully described in an article published in the "Electrical Review" for March 4th. In this connection should also be noted a decision recently rendered, compelling the Western Union Telegraph Company to turn messages of a customer over to the Postal Telegraph Company on an order from the customer, and should the same position be held by the courts in deciding the telephone case we have cited, a new element will be introduced into the telephone situation.

Ever since the expiration of the fundamental Bell telephone patents, there has been an effort made throughout the country to install local exchanges in small towns, a territory rather neglected by the Bell management. These exchanges have often proved to be great successes, but they have invariably encountered subsequent demands from their customers for outside line service which could not be successfully maintained by the small exchanges, especially in the face of existing Bell connections. If now the courts will hold that the Bell Telephone Company is a common carrier and that it must hold its lines open to messages collected over the wires of a local exchange, as well as to those which come directly to the doors of its pay stations, we will soon see a vast extension of telephone exchanges, either by an extension of the present system of local companies or by the Bell company entering this field in direct competition for this class of business.

TRANSFORMERS FOR NET-WORK DISTRIBUTION.

We are gradually beginning to appreciate the importance of secondary wiring net-works operated from large transformers in place of small local transformers, each devoted to a single lighting point. The question of how far this may be economically carried is discussed in Germany in an article in the "Elektricitats Zeitscrift" for February 27th, in which the author, Herr Haas, points out that there is a point of minimum installation cost in any such system of distribution. This point may be found by plotting curves representing respectively the cost of secondary leads and the cost of transformers in any particular case. Obviously, the cost of copper will increase as the distance from the lights to the transformer increases, while the cost of transformers will increase as we decrease the amount of copper in the secondary mains. The resultant curve obtained by adding these two quantities will show for any case the minimum point at which the location of various transformers for feeding a given net-work is determined, as is also the size of the transformers to be employed. Herr Haas has endeavored to reduce the problem to an equation giving a general solution. It is obvious to any one who has attempted such a problem that the conditions are always so widely varied that no equation can be found which will satisfy many cases, but at the same time relative costs of transformers and copper may be drawn in curves and the minimum point of the resultant curve found graphically. Graphical methods such as this can readily be applied to the solution of all such problems which require judgment and for extensive application will not only result in the best engineering, but will also give the designer of any plant a more complete faith in his own decisions.

THE EFFICIENCIES OF BOILER FURNACES.

The important series of tests made by the Chicago Edison Company upon the Hawley down draft furnace and the Mackenzie boiler furnace have been published in the "Electrical Engineer" for March 11th, Mr. B. R. T. Collins, engineer of the tests, which show not only that the problem of smoke prevention is practically solved by either one of these devices, but that the efficiency obtained from the use of either one of these two furnaces is satisfactorily high.

Two sets of tests were made with each boiler, one for obtaining the most economical evaporation, the other for

ascertaining the economy at maximum capacity. The very remarkable result appears from these tests that while the Mackenzie furnace is the least efficient at low loads by about 2 per cent, it maintains the efficiency first obtained when severely forced; while on forcing the Hawley furnace, its efficiency falls off about 9 per cent, though before judging immediately upon this result we should notice that while the Hawley furnace at maximum capacity develops more than the rated horse-power of the boiler, the Mackenzie furnace does not succeed in obtaining the full rating of the boiler to which it was attached, and this may possibly explain the high efficiency obtained when forced. However, the Mackenzie furnace does not fall off in maximum capacity below that of the rating of the boiler enough to account for the entire difference in efficiency. The efficiency obtained with these different furnaces are as we have said commendably high, so that one need only determine which furnace to use by comparison of the cost of installation and maintenance in the two systems.

The Hawley furnace requires a water tube grate since the principal amount of fuel rests upon the grate bars, through which the draft passes in a downward direction, and in consequence one would expect the furnace to be subject to a large repair account, while on the other hand the Mackenzie furnace, admitting air for combustion through fire brick pillars in the combustion chambers, would naturally require a large installation cost and would also be likely to entail a large loss in heat when fires were banked—a loss from which the Hawley furnace would be free. The tests given point clearly enough to the relative economy of the two furnaces under the given conditions as we have stated, but we believe we do well in calling attention to the fact that the tests given do not furnish data for choice between the two furnaces, on account of the omitted items necessary for a complete comparison.

Literature.

THE VOLTAIC CELL: Its Construction and Its Capacity, by Park Benjamin. New York: John Wiley & Sons, 1893. Pp. 562. Price $3.00.

In his preface, Dr. Park Benjamin states: "The object of this book is to assist the student and investigator by placing before him a record of the principal discoveries and results relating to chemical generators of electricity, descriptions of many of the most distinctive and approved types of cells and the latest knowledge as to their efficiency, measurement and modes of use.

While undoubtedly carrying out the object thus stated, of furnishing for students elementary information concerning the many types of voltaic cell, we miss the valuable criticism of various plans that could be only furnished by an independent investigation, rather than by a compiler. Though much more limited in scope, Prof. Carhart's little book, treating of primary batteries, carries with all its statements the authority of an investigator whose work is independent of any hope for patent rewards and in consequence, the cells treated are better known to the reader from his book than they can be known from the compilation of Dr. Benjamin.

Perhaps the most valuable chapter in this book upon the Voltaic Cell is the third, in which is treated the subject of electric measurements from the standpoint of a practical engineer who uses portable direct reading voltmeters and ammeters, rather than apparatus adapted only to the physical laboratory. All of the measurements necessary for an engineer's knowledge of a voltaic cell are here described in a clear manner with the use of apparatus available to every engineer likely to undertake the complete investigation of a primary battery. As a compilation of descriptions of cells and patents upon various types of voltaic cells, Dr. Benjamin's book certainly leaves little to be desired. An authoritative statement of their working could only be obtained by an exceedingly extensive and long series of investigations, certainly longer than would be possible for any one investigator to carry out. A further value of the work lies in the fact that the authorities for the various cell descriptions and tables of data are not only given throughout the text, but the book is supplemented with a complete bibliography of books and papers referred to throughout the text. From the standpoint of an independent investigator, Dr. Benjamin's work leaves much to be desired since the information given is generally that published by those interested in a particular type of cell, though as a book for reference, when a description of a particular cell is desired, this complete description and complete bibliography is very valuable to the engineer.

JAMES CLERK MAXWELL AND MODERN PHYSICS—The Century Science Series, by R. T. Glazebrook. New York: Macmillan & Co., pp. 225. Price, $1.25.

This account of Clerk Maxwell's work rather than of his life from the pen of one of his earliest students at the Cavendish Laboratory loses nothing of its interest from the previous publication of the great biography of Maxwell written in 1882 by Prof. Lewis Campbell and Dr. Garnett. The previous work presented to us the man Maxwell, while this short review brings us more closely in contact with Maxwell the worker, though Prof. Glazebrook himself acknowledges that Maxwell was a man of so strong a personality as to make a complete separation of his work from himself an entire impossibility, but on perusal of this book we are led almost to think that Maxwell's life and work were not so closely connected as Maxwell's work with the entire progress of electrical science since his time. One is in fact bewildered in contemplating the life of this great man and ralizing how completely most modern discoveries are involved in the impetus which he gave to experimental physics at Cambridge University and particularly in the advances he was able to make in the theory of electricity and magnetism. Born at so late a date that had he lived until the present time he might not yet be considerd an old man the enormous mass of business and knowledge involved in the term electrical engineering may be said to have found its origin in his investigations and yet, as Prof. Glazebrook has shown us in this life, his career was not solely important on account of his great electrical investigations but also on account of his studies in optics and molecular physics. Reading this review we are more than ever struck with the comparatively great opportunities offered to the present student who has laboratories at his disposal and instructors to aid him far more competent than any Maxwell found at the beginning of his student career, though again we are brought by Prof.

Glazebrook to acknowledge our indebtedness to Maxwell for these opportunities of learning. Maxwell impressed the importance of experimental knowledge upon the Cambridge Examiners; through Maxwell's efforts the Cavendish Laboratory was established, and after it was established Maxwell was the only competent director able to inaugurate experimental physics at the great university. It is perhaps an old story to the present grown generation of physicists that we owe this much to Maxwell, but the importance of this work might be lost sight of in the coming generation unless the rising students should have his position in science clearly defined to them, and for this we are indebted to Prof. Glazebrook, who has written of Clerk Maxwell's work in a manner that is at the same time complete and interesting. It is to be hoped that the book will find its way into the hands of many students of experimental physics and that it will cause them to place Maxwell in his true position as the founder of the mathematical theory of experimental physics.

WESTINGHOUSE ELECTRIC STREET CAR EQUIPMENTS.—By F. L. Hutchinson and Leo Phillips, East Pittsburg, Pa., 1896. Published by the authors. Pp. 91. Price $1.00.

Within the past few years engineers connected with the various manufacturing companies have published descriptions of the machinery with which they are familiar that are exceedingly valuable to the electric public, aside from their value as an advertisement to the manufacturer concerned. This little book, describing the Westinghouse street car equipment, reperesents the best offered in this class of literature, since it puts into the hands of practical men a description of the various pieces of apparatus used in street car equipments by the Westinghouse Company, and furnishes a clear explanation of the duties of the various pieces of apparatus, and explains the care which should be given them without at any time entering upon an argument in favor of the apparatus described, or detracting from that of other manufacturers. Indeed, quite properly, the book might be called a "Manual of Management," and it will prove of value to street car companies using this apparatus, should they place it in the hands of their employes.

In several chapters the motors and car controllers are described, and following these chapters the operation of the car equipment is explained. The correct method of inspection is laid out and instructions are given for localising and remedying faults, followed by instructions for repairing and rewinding fields and armatures. In reading this list of contents, it is plain why we have called this book a manual of management, since no hint is given of proper carwiring, nor is the internal method or operation of controllers and other parts of apparatus explained. Perhaps the points not explained are those which the manufacturers desire to keep under their own control, though how this will be generally possible is difficult to see, for the inquisitive engineer of the present day is fully capable of tracing out the connections of any controller or car-wiring system. Since this is so, it would seem rational for the manufacturing companies to give such clear instructions concerning these points to those using their apparatus, that all may have equal benefit from their explanations. The matter throughout the book is carefully divided into paragraphs separately titled, but we regret to notice the absence of an index which would facilitate ready reference to the information which the book contains. It is to be hoped that other manufacturers will follow the lead here given with an equally clear and explicit set of directions for managing the various pieces of electrical apparatus which they sell.

JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY FOR 1896.—Containg lists of electric light central stations, isolated plants, mining plants, street railways, telegraph, telephone and district messenger companies, and manufacturers of and dealers in electrical street railway apparatus, machinery and supplies. 832 pages; cloth. Price $5.00. New York: The W. J. Johnston Company.

In the production of this work, the only one of its kind in America, the object of the compilers is to furnish reliable information regarding electrical, street railway and kindred interests, so arranged and classified as to be of the most practical value and easily accessible. Apart from the convenient classification and arangements of its contents, the Directory gives, among other things, the names of managing officers, superintendents, electrical engineers, purchasing agents, etc., of the different electric light, street railway and other companies; the capital paid in, system in use, etc.; number of lights operated by electric light companies, and whether they furnish electric power; prices paid for city lights by 353 cities and towns; length of each street railway, number of cars operated and equipment in use. According to the figures given in the Directory, there are in the United States and Territories, Canada, Cuba and Mexico, 2711 electric light central stations, with an aggregate paid-up capital of $320,049,518, and 1140 street railways with a total paid-up capital of $890,828,120. 828 of these street railways, with a mileage of 14,850, are operated by electricity, and 312, with a mileage of 2300, by horse, steam or cable power. The Directory also publishes a list of 7150 manufacturers, dealers, electrical engineers, etc., engaged in or catering to the electrical business, and arranged in three different ways: Geographically by States, cities and towns; classified according to lines of business, and alphabetically as a finding list. The scope of the Directory is not confined to the United States, but includes Canada, Mexico, Cuba, Central and South America.

Telephony

CHEAP TELEPHONES IN SAN FRANCISCO.

The Pacific Telephone and Telegraph Company of San Francisco has issued the following to the public: The management of the Pacific Telephone and Telegraph Company, believing that outside of the 1659 residence subscribers connected with the San Francisco exchange, there are two or three thousand or more, householders who really need telephones and do not know it, never having used one regularly, has decided, for advertising and educational purposes, to issue 1000 kitchen telephone sets at the rate of 50 cents per month for the installation of the kitchen telephone and unlimited switching from house to office, or from house to physician, or from house to any other one subscriber in the San Francisco exchange.

Other switches from this telephone may be made to any other one of the 6715 subscribers (connected April 1st, 1896) by the payment of a nickel at the time of making the switch; or the subscriber can contract for 50 cents a month additional, for unlimited switching with any other one subscriber; or by the payment of $1.75 per month he can have unlimited switching from this telephone to all of the subscribers connected with the San Francisco exchange.

This telephone is placed in the kitchen only, where it can

be readily used to the butcher, grocer, coal dealer or to the physician, druggist, etc. These telephones are for outward service only, and on account of the saving made by the company, in the fact that no arrangements are made at these telephones for being called up, and the saving at the central office for the same reason; and as for this purpose, a number of stations can be placed upon one pair of wires; and as stated above, for the general benefit such a service will be to the system as a whole, and as an advertisement, and as an educator for the present non-subscribers, the telephone and all the service mentioned is given at the rates quoted above.

The terms for regular residence service, which includes metallic circuit, long distance transmitter, express service and unlimited use, are $5 per month, or $2.50 per month and five cents for each outgoing switch (inward service free).

This is the service we know you will want a little later on, after you find, as you surely will, that the telephone is as necessary in your household as gas or water.

Pneumatics

COMPRESSED AIR AT THE NORTH STAR MINE.

Since the completion of the Rix air compressors described in the November number of the Journal, the compressed air taken therefrom has been applied to various uses in and about the North Star Mine, Grass Valley, Cal., the most interesting of which are the pumping out of the old shaft on Massachusetts Hill, and the operation of the compound pneumatic hoist. Sixty miner's inches of water or something over a million gallons a day is the amount pumped and even this quantity taken from the old workings does not seem to decrease the supply rapidly, for there are miles of drifts to uncover. The inflow appears at present to be about 600,000 gallons a day, representing a gain on the water of 400,000 gallons daily.

After passing through the reheaters heretofore described, the air is applied at a pressure of 90 lbs. to the 12-inch high pressure air cylinder of the compound differential plunger pump, built by the Dow steam pump works of San Francisco. In passing through the reheater, the temperature of the compressed air is raised to 350 deg. F., and its volume is increased from 40 to 50 per cent., and after being released from the high pressure cylinder the cool air is again reheated to a similar extent and piped to the low pressure cylinder which has a diameter of 14 inches. These cylinders are in tandem and their piston has a stroke of 30 inches. The pump, which is illustrated herewith, has a capacity of lifting 700 gallons per minute to a height of 350 feet and is of the following further dimensions: Diameter of lower and upper plungers, 14 inches and 10 inches respectively; suction, 10 inches; delivery, 8 inches; air pipe, $2\frac{1}{2}$ inches.

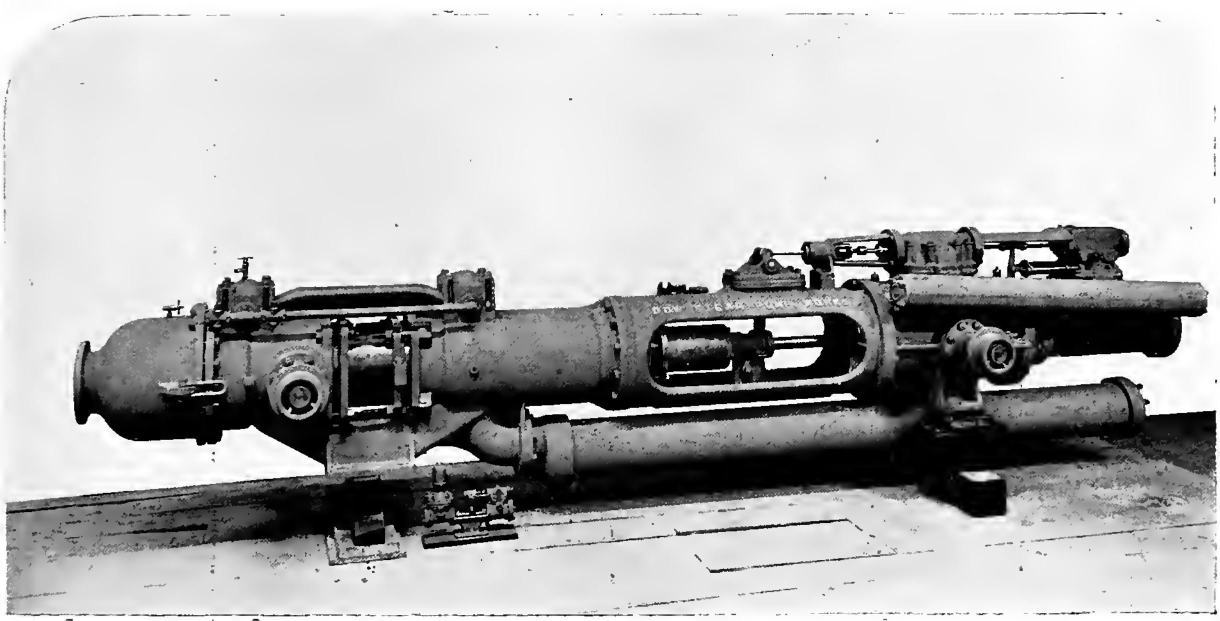


FIGURE 1.—THE DOW COMPOUND DIFFERENTIAL PLUNGER PUMP, OPERATED BY COMPRESSED AIR AT THE NORTH STAR MINE

The two trunions shown in this cut, one being bolted on the low pressure air cylinder and the other to the water end, are used in connection with a hoisting apparatus for raising and lowering the pump. The pump is built from Dow's latest design, and by an improvement in the construction of the water end, all shock or concussion is done away with, and the pump runs noiseless and without jar. The pump weighs, without water, 15,000 pounds, is twenty-two feet long and is suspended between guides in the pump shaft by a steel wire cable. A special triple geared hoisting engine raises or lowers it in the shaft easily, so that when blasting, or when repair, or repacking is necessary, it may be brought to the surface in a few minutes.

The hoist referred to is a double drum direct connected outfit, operated from two Corliss steam engine cylinders, one of which receives the air at 90 lbs. pressure from the reheater as above. In this first cylinder the air is cut off at about one-half stroke and is expanded to about 25 lbs., whence it is again reheated and applied to the second cylinder. The amount of fuel used in the reheater is about 1-5 the amount required to produce the same harse-power by steam.

The Trade.

IRON-CLAD ARC ARMATURES.

Realizing that the iron-clad armature has almost completely driven the surface wound machine from the market in constant potential work, the Western Electric Company has designed and put in service a complete line of arc machines having iron-clad armatures and other new features.

The general form of construction of these machines is shown in Fig. 1. The frames are of the bipolar, horseshoe type, with the magnets horizontal. The magnet cores are of wrought iron and the pole pieces and yoke are of cast iron. The bearings are of the self-oiling, self-aligning type, and are provided with visual oil guage and drain. The pulley end bearing is bolted directly to the yoke of the dynamo and the commutator end bearing rests on a brass bracket projecting from the lower pole piece. The bearing bracket is bored out at the same time the pole pieces are bored, so that the removal of the armature is a very simple matter. The bolt can be taken out and the bearing turned around the shaft until the foot is clear of its seat and the armature will then rest in the pole pieces and the bearing can be slid off with a very slight exertion. The simple fact that the armature may be so easily and quickly removed for examination or repairs is a point that is fully appreciated by all central station managers. The bearing may be removed in about five minutes, the pulley in three and the commutator in ten.

The most vital part, in all dynamos of high potential, is the armature. If the armature is not thoroughly insulated and designed for comparatively cool running the machine is destined to a short life. The care taken in procuring first-class insulation of the armature is shown in Figs. 2 and 3, which can readily be understood by reference to the following description:

The armature is built up of very thin sheet-iron rings mounted on a brass spider. The sheet-iron rings have teeth similar to those in the standard incandescent iron-clad armature, the coils are wound in the slots between the teeth and are firmly held in place by wooden wedges, which are driven in over the top of the winding. The armatures are divided into a very large number of coils of comparatively few turns of wire. In this way the voltage in the individual coils is reduced to such a small amount that there is very little strain on the insulation between coils and the voltage between segments of the commutator is so low that it is difficult to flash the machines under ordinary running conditions, and if flashing does occur, the effect on the commutator is scarcely noticeable. By dividing the winding into a large number of small ventilated coils the accumulation of heat in the center of the coils is avoided, thereby preventing the slow roasting of the insulation which occurs in some machines.

The coils are insulated from the core in the slots by a trough which is built up of alternate layers of press board, mica and oiled paper, the sheets of mica being well lapped to avoid any chance of puncturing at the joints. The coils on the inside of the armature are wound in insulating troughs somewhat similar to the troughs in the slots, with the exception that they are narrower and deeper. The ends of the coils are insulated from the core; first by wooden rings which are placed at the ends of the armature and form rounded corners to wind over as well as affording additional insulation; second, by built up "U" shaped troughs which overlap and extend in and around the inside and outside troughs, so that the result is that each coil is wound in a seperate trough built up of four overlapping troughs which effectually insulate it from the armature in Fig. 3.

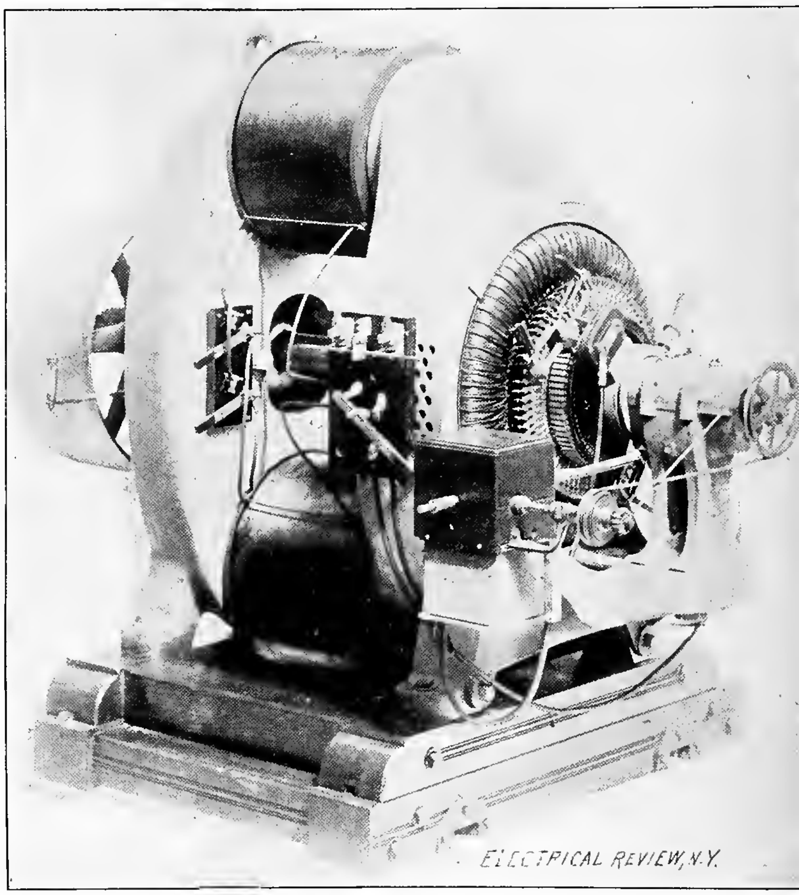


FIG. 1—WESTERN ELECTRIC IRON CLAD ARC LIGHTING DYNAMO

The advantage of this form of construction is at once evident in case repairs become necessary, as any coil can be rewound without affecting the other in any way, and as there are no bands all that has to be done is to slip the armature far enough out of the pole pieces to work on it, and then take off the commutator, rewind the coil and put the armature and commutator in place again. In case one or even four or five coils in an armature become injured it is not necessary to rewind them at once, for if a coil is not short-circuited internally the terminals of the coil can be simply disconnected from the clamp on the commutator and a small jumper put across the same segments to which the coil was previously connected, and the machine can be run with no serious increase of sparking.

If any of the injured coils are short-circuited internally of course the short circuit must be gotten out, or the whole coil may be cut out with a cold chisel. If this is done, it is necessary to take out the opposite coil also in order to keep the armature in running balance. A wooden wedge in-

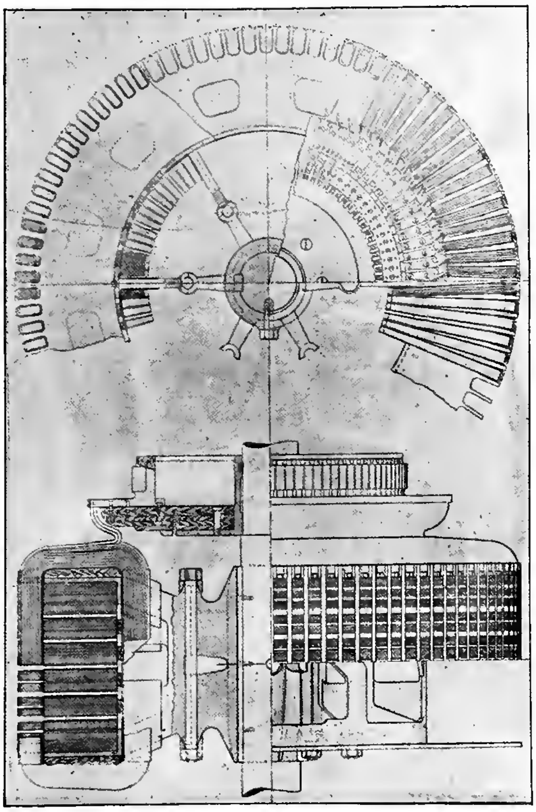


FIG. 2—DETAIL DRAWING

serted in the place of the inner portion of the coil will serve to hold the other coils in place. The success of the system of ventilation adopted is shown by a test in which two armatures were built just alike except that one was wound in the usual way, and in the other the coils were ventilated as shown in the cuts and described below. The former heated 80 F above the air after a 12 hours' run, while the latter only heated 60 F after a 24 hours' run.

The armature discs are supported by extensions on the spider. These points of support which are about two inches wide are directly over the spider arms as shown in Fig. 2. Between the spider arms, in the open spaces, are laid small wooden blocks about one quarter of an inch thick which separate the armature coils from the discs and between every three or four coils on the inside of the armature are ventilating spaces. These ventilating spaces, which are shown very plainly in Fig. 2, open into ventilating chambers in the brass ring which carries the armature discs and this space communicates directly with the spaces between the iron discs which are, of course, open at the outside where the iron teeth come between the coils. By this means there is a free circulation of cool air in through the coils, coming in at the bottom and flowing up through the ventilating spaces between the armature discs and out between the armature teeth. In addition to this the brass spider arms are partially cut away where they pass through the winding at the bottom so that there is an additional opening for the admission of fresh air into the spaces between the armature rings. The iron armature rings are held apart in bunches of about sixty, by radical strips of asbestos which, from

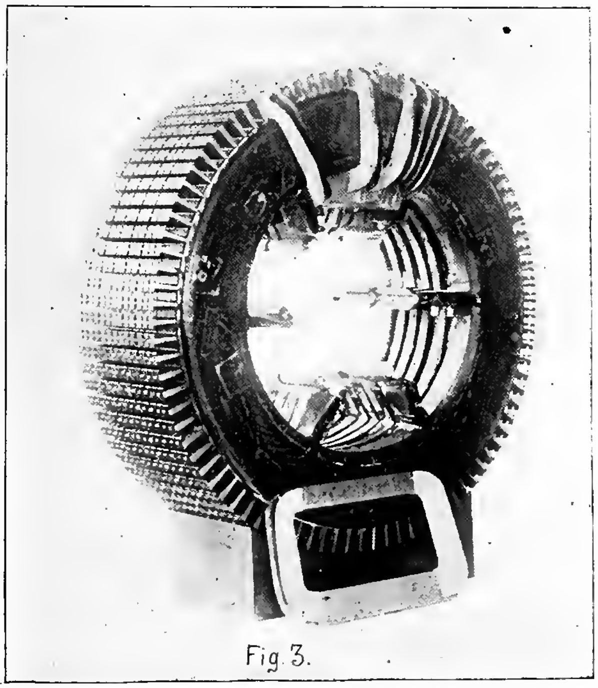


FIGURE 3.—ARMATURE CORE, READY FOR WINDING

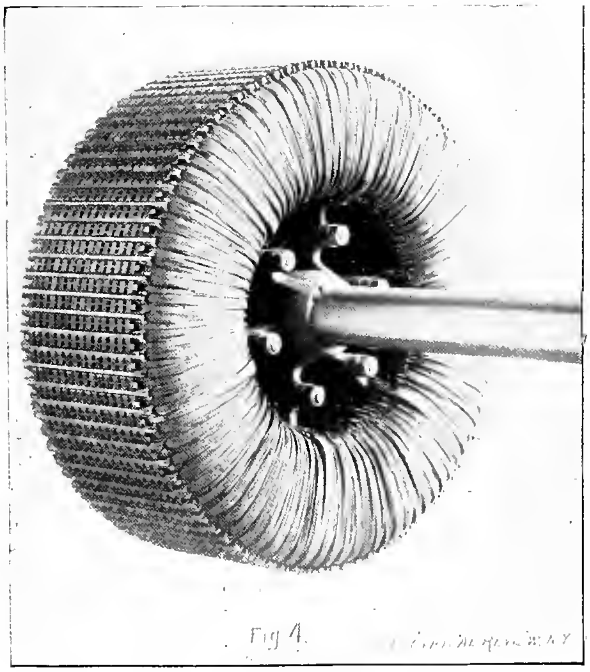


FIGURE 4—ARMATURE COMPLETE, PULLEY END

their action as a centrifugal blower, tend to keep the cool air flowing through the armature.

The special feature of this system of ventilation and insulation is that the entire ventilating space in the armature may be filled up with carbon or copper dust, leaving the insulation of the machine as strong to resist the breaking down strain, due to the voltage, as it was before, for the reason that each coil is insulated independently of the rest in a trough which completely protects it.

The field coils are wound on paper spools $\frac{1}{8}$ to 3-16 of an inch thick, which are built up and flanged over outside of the $\frac{1}{2}$-inch wood veneering heads. The spools are held away from the iron core and the yoke, and pole pieces by wooden wedges so that there is a large ventilating space all around the inside and at the end of the spools. The construction of the spools is such that should this ventilating space become filled with dirt the coils are still effectually insulated.

On the yoke of the machine shown in Fig. 1 is mounted a pair of reducing switches which cut out part of the field winding. The lower switch is for the purpose of adjusting

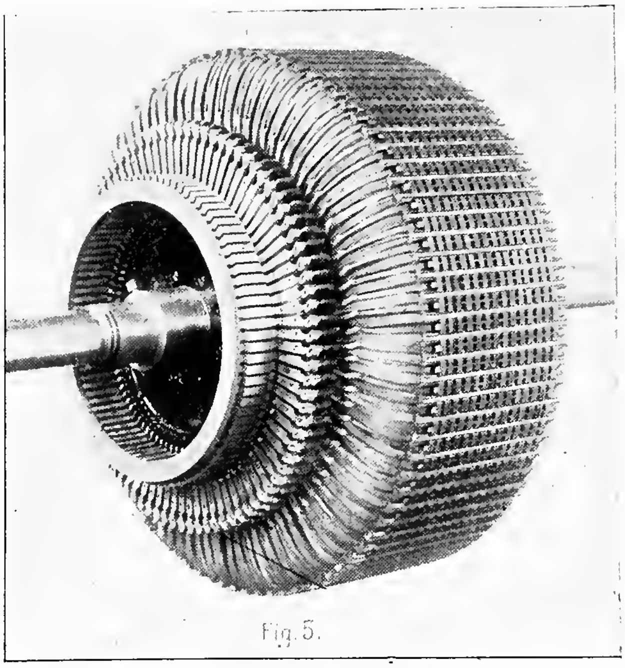


FIGURE 5–ARMATURE COMPLETE, COMMUTATOR END

the spark at the brushes to the conditions under which the dynamo is running. When this switch is open the machine will run along without flashing under normal conditions, though the spark is in this way reduced practically to nothing. If there are sudden and great changes of load, it is desirable to have the machine run with a slightly longer spark so that it will not flash before the regulator has a chance to compensate for the change in the load; this can be accomplished by simply closing the switch.

The other reducing switch is for the purpose of reducing the current output of the dynamo so that if it is desired to run the machine part of the time at a lower current than 9.6 ampers this switch can be closed and the regulator adjusted to the lower current. In this way considerable fuel can be saved when it is not necessary to run the lights at full brilliancy.

The commutator, which is shown in detail in Fig. 2 and complete in Fig. 5, is built up in a very substantial disc of hardwood veneering, which is mounted on a brass flange. This wooden disc is then faced with mica and each segment is screwed to it independently of the others. The segments are tapered slightly towards the inside, allowing slate wedges to be driven between them, thereby protecting the mica facing from the action of any burning that might be caused by the flashing of the dynamos. The outside ends of the segments are held rigidly by a compound ring of mica and veneering, and each segment is held in position on this ring by a machine screw and two dowel pins. The segments are insulated from each other by air spaces, allowing both sides of each segment to be perfectly inspected and cleaned at any time when the machine is not running.

With an air insulated commutator the burning effect of a flashing and short circuits is confined almost entirely to the brushes so that it is not necessary to turn down the commutator after bad flashing, as the case with solid-built commutators. The carbon brushes feed down and compensate for the burning as soon as it is over. All parts of the commutator, which are connected with the circuit of the machine, are on the face of the wooden disc so that there are no parts behind the commutator which have to be cleaned to keep the insulation from running down. Also all screws used in its construction are accessible from the front. The segments are increased in size at the working part so as to provide for a long life, and also to hold the flashing as much as possible in the working part of the segments. This form of construction has the additional advantage that it is not dependent on slate or rubber or any other brittle material for its mechanical support, and yet the mechanically substantial insulation is thoroughly protected by the slate wedges from the burning action of flashing.

The brushes are arranged to cover the commutator over the entire angle spanned by them, and whatever sparking occurs, is concentrated at the tip of the brush. At the brush tip is provided a small independent brush which is automatically fed down to compensate for the increased wear due to the sparking at this point. This independent brush is so narrow that the brush angle remains practically constant, no matter how fast the brush may be worn away by sparking. The tension of all brushes, there being four to each holder, is adjusted by vulcanite handles, carrying a worm screw, which slip down over ratchets; by turning the rubber handle carrying the worm screw the brush tension can be adjusted accurately, and when it is desired to replace a brush the handle and brush spring can be removed entirely from the brush holder and the carbon taken out and inspected or renewed.

In some of the older forms of carbon brush-holders used on air insulated commutators considerable annoyance was experienced from the noise caused by the chattering of the brushes. This has been almost entirely obviated by the construction adopted. In these brush holders the main brushes cover several segments at once and all the brushes are urged by springs in the direction in which the commutator rotates, so there is no chance for the brushes to vibrate. With these brushes it is not necessary to oil the commutator.

The lamps can be thrown off or on in groups equal to 10 per cent of the capacity of the machine from full load down to short circuit or vice versa, and the regulator will compensate for the changes without flashing the machine. Or the whole load may be thrown on or off instantly and the regulator will compensate for the change in a few seconds.

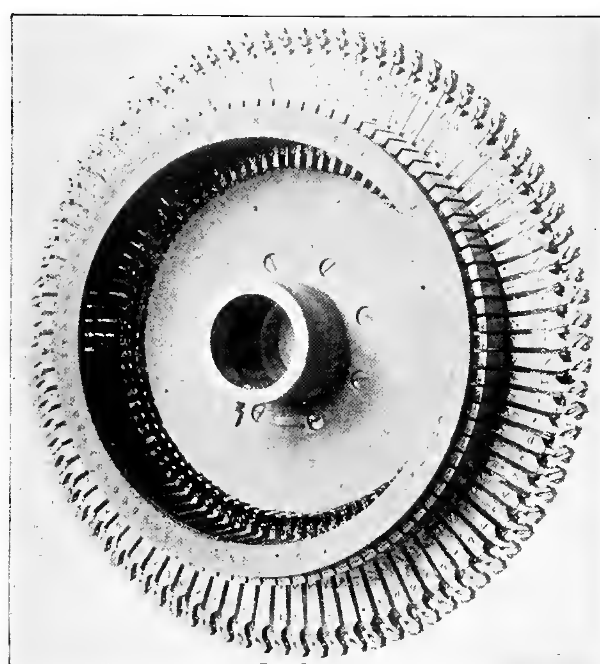


FIGURE 6.—COMMUTATOR COMPLETE, READY FOR MOUNTING

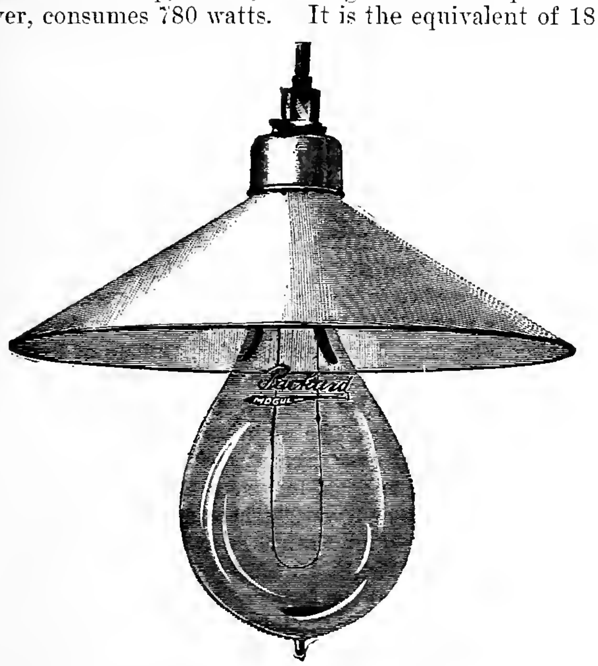
The machines withstand without injury the ordinary accidents of operation, such as open circuit and short circuit, and either side of the circuit may be grounded to the frame and the circuit opened without injuring the insulation. The machines are all designed to run fourteen hours on any load from dead short circuit to full-rated capacity without heating in any part more than 80 degrees Fahrenheit above the surrounding air.

The California Electrical Works, of 35 Market St., San Francisco, handle these iron clad arc lighting dynamos, together with all other lighting or power machinery of the Western Electric Company as its Pacific Coast agency.

A PHENOMINALLY SUCCESSFUL FIRM.

The business of the firm of J. W. Brooks & Co. has been turned over to the Brooks-Follis Electric Co., consisting of Messrs. J. H. Follis and J. W. Brooks, and the combination thus effected fittingly illustrates what can be accomplished in the electrical line on the Pacific Coast under the guidance of energy and keen business acumen. Although one of the youngest concerns in San Francisco, it is probably one of the busiest, and the quarters recently leased by it at No. 523 Mission street are fast becoming inadequate to handle the business that is being developed. Having a select line of agencies, and combining therewith the knowledge that business can best be secured through low prices and the liberal use of the advertising pages of a select publication, the firm has sprung into favor to so great an extent that even the largest of the manufacturing companies are beginning to feel the inroads made into their business and are adopting methods by which it is hoped to check the growth of this sterling concern. Among the orders recently filled by the Brooks-Follis Co. is a carload of carbons of the American Carbon Co., shipped to the Los Angeles Electric Co., and 5000 Packard lamps for the Big Creek Power Co. of Santa Cruz.

The Pacific Coast sales agency for the New York and Ohio Co., manufacturers of the well-known Packard lamps and transformers, has been placed with the Brooks-Follis Electric Co. In addition to the usual sizes and efficiencies of incandescent lamps, the Packard "Mogul" lamp has attained popularity. This is a 300-candle power incandescent lamp, which, burning at 2.6 watts per candle power, consumes 780 watts. It is the equivalent of 18 ¾,



THE PACKARD "MOGUL" LAMP

THE PACKARD TRANSFORMER

16 c. p. lamps, which, burning at the ordinary efficiency of 3.6 watts, consume 1080 watts. There is thus a saving of 300 watt hours in favor of the "Mogul" for an equal amount of lighting service. The Packard transformers are also guaranteed by the manufacturers to be unsurpassed in regulation, efficiency and convenience.

THE PORTLAND GENERAL ELECTRIC SUPPLY HOUSE.

The Portland General Electric Co., furnishing current for the operation of all electrical industries in and about Portland, Or., with the exception of the City and Suburban Street Railway Co., has determined to go into the electrical supply business on an extensive scale and is now fitting up three large ware-rooms in the building opposite its office and sub-station on Seventh and Alder street, where it will be prepared to fill all orders of whatever magnitude direct from stock. This stock will consist of everything essential to the installation, operation and maintenance of electric lighting and power work and will include not only dynamos, motors and all accessory equipment, but also supplies of every description for wiring purposes, even to fixture work. Without doubt, the supply department of the Portland General Electric Co. will very shortly become the headquarters for electrical supplies for the States of Oregon, Washington, Idaho and Montana.

FORCING PLANTS BY ELECTRICITY.

Some highly interesting experiments in the development of plants by the electric light have been concluded by the Cornell department of horticulture. By using electric light during the day time, Prof. Bailey produced lilies fully two weeks before the plants grown under natural conditions flowered. The effect on lettuce was very marked. The plants were larger and much more rapid in growth than those raised in the ordinary way. Investigations are to be continued on different plants, and the effect on vegetation of the Roentgen rays will also be determined. Tests will also be made on plants by electrifying the atmosphere in which they are grown. Ozone is specially grateful to some classes of plants, while to others an abundant supply of it does not appear to be essential. The same difference is found in plants subjected to the influence of the electric light. For instance, while lettuce thrives astonishingly under the electric light treatment, electricity is a positive detriment to peas.

AN EXTENSIVE TELEPHONE SYSTEM FOR JAPAN.

The Engineers of the Department of Communications of the Imperial Government of Japan have received instructions to prepare estimates of cost for the surveying, designing and installation of an extensive telephone system that will connect every portion of the island with metallic service. The long distance lines of the proposed system will altogether aggregate 25,000 miles in length and the plan contemplates the establishing of 40 main offices and 180 public stations, which will be capable of handling 25,000 subscribers At present telephone exchanges are in operation in Yokohama, Tokio, Osaka and Kiobe, while in August next an exchange will be in operation in Kioto. The system will embody both land and sub-marine construction and the line construction will probably be begun in the summer of 1897. The cost of the work is estimated at $7,000,000.

DON'T ALL SPEAK AT ONCE.

That it is necessary for a trustworthy and successful electrician to have widely diversified talents before being able to attain his mark in the world, has long been appreciated, but perhaps, if indications do not fail, by none more thoroughly than by the writer of the following letter, which was recently received by the Journal of Electricity.

Sir: What kind of an Ad. will you publish in your paper, which I observed in a news-stand, for, say four bits? I'm endeavoring to get mechanical work, in the electrical line if possible. The Electrical Review in December published a plaint from an Eastern man who could not seem to get the work he wanted, simply because he wanted it, probably, and I wrote a similar one which was also put in; a fine place, too; regular reading matter! January 16th issue, I think. I never received a single reply to it! Perhaps I am too far off. For that reason I tho't it would pay me to pony up 50c for a local paper.

Fate seems to will that I get anything but mechanical work. Am hanging on to an office job at present (can keep books), but it's ruining my eyes. Experience through three years in electrical work: bell hanger's "wire pulling" (the only "pull' I ver had!) Also to manufacture small apparatus and tending gas-engine-dynamo combination.

Have recommends. One from last employing company (now defunct). Understand m'f'ure, care and action of apparatus in general and batteries. Some chemical knowledge. Drug store experience one year: sign painter (show cards), and a fair window dresser. Will go town or country.

As an inducement to the locality furnishing me work, I wil be found a very desirable addition to any musical organization fostered by such community, as I will be found capable of filling the first or solo B flat cornet chair in the town's band (they all have 'em, you know), as I have experience through seven years as cornetist from church lofts to brass bands Have made electric work my object, being mechanically inclined. (Of Yankee extraction.) Have had any number of free insertions in the musical journals, but being all Eastern published, Eastern men were handier, I suppose. 19 years old, good habits, etc.

Any one desiring the services of such party, please address "B." Journal of Electricity.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

The difficulty of getting cordwood is constantly on the increase, especially as a close watch is now kept upon the cutting of timber on public lands. It is inevitable that cheap electrical power must come before Mariposa can take her legitimate place among the great gold-fields of the world.—Mariposa (Cal.) Gazette.

Electrical power enterprises are just now demanding great attention throughout Utah. Water power for the generation of electricity is abundant, and a wide and profitable field for the application of this cheap power is presented by the mines and mills in the mountains and the manufacturing plants in the valleys. Chained lightning promises to greatly stimulate the development of great manufacturing resources. A region so rich in raw materials, and supplied with the most economical power known to mankind, with a belt extending from the British possessions to the Mexican boundary as its market, has limitless possibilities before it.—Salt Lake City Mining Review.

The use of electric roads (for hauling freight cars to points in country districts away from the steam railroad lines) would be very applicable here in Southern California, where there is so much produce of a valuable character raised within a small area of country. For instance, it would be a good thing for the electric road which runs from Los Angeles to Santa Monica to try the experiment of putting on a few freight cars during the winter, when winter vegetables are being shipped to San Francisco and the East. The general introduction of such roads would make the farmers in the neighborhood of a large city to a great extent independent of the railroad companies.—Los Angeles (Cal.) Times.

The Z. A. Willard syndicate of Boston is, it is learned, through Mr. J. H. Linn of Murphys, Cal., already engaged in making the preliminary surveys for the installation of an electric power and light plant to be located on the middle fork of the Stanislaus river. It is intended to make it one of the largest and most complete power stations in the State and will have a capacity of fifteen thousand horse-power. Application will soon be made to the Board of Supervisors of both Calaveras and Tuolumne county for the necessary franchise, as the company expects to substitute electricity for steam power in nearly all the mines and industrial enterprises in both counties. The rapid growth of the mining industry in this section makes it necessary that some such agency be employed for power instead of steam in the development of the mining interests. There are untold numbers of low-grade undeveloped properties in both counties, that with cheap power can be made to pay a nice profit, while without it they must continue to lie dormant. The progress of this region has no more unrelenting and ever present obstacle in its path than the cost of fuel and in some instances the scarcity of water. In Mariposa county they have felt the same drawback so keenly that the aid of a San Francisco syndicate of capitalists has been enlisted by Mr. H. H. Clark of the Horseshoe Bend, to erect a power plant at the famous bend of the Merced river, four miles from the town of Coulterville, and before a pick was struck contracts had been made for furnishing nearly all the power they can develop. The same condition will prevail here

before long; not only in the field of power supply but electric light as well, will there be found a profitable business. The booming mining camps of Jamestown, Quartz Mountain and Stent already justify the extension of a system of lighting in their midst. The three places are situated within a radius of three miles and since the sale of the Whiskey Hill group to a Boston Company, much is expected from the former town in the way of rapid growth. The necessity for the introduction of additional lighting and power facilities is becoming so apparent that no corporation would experience much trouble in floating enough of their stock to insure the success of the undertaking. Mr. J. H. Linn, who represents the syndicate in this county, is quietly pursuing a thorough investigation into the feasibilty of the project in so far as it relates to the section lying south of the Stanislaus and has met with so much encouragement that his report will be of a roseate hue.—Sonora (Cal.) Democrat.

Reports of the Month.

INCORPORATION

Willits, Cal.—The Mendocino Electric Company is about to be incorporated by W. A. McCornack, Albert Brown, Charles Packard, L. A. Morgan, J. D. Johnson, Joshua Grindle and William Heeser, for the purpose of furnishing electric light and power for Mendocino and vicinity.

Sonora, Cal.—The Tuolumne County Electric Power and Light Company. Authorized capital, $1,000,000, of which $666,-641 has been subscribed. Directors: W. D. Baumister and James McCormick of Tuolumne county; William Grant, A. F. Fechteler and David Hearfield of Marin county, and John J. Crook and P. R. Jarboe of San Franciso.

San Diego, Cal.—The Citizens Traction Company, capital stock $100,000 of which $800,000 has been actually subscribed by the following directors: George B. Kerper $57,400, C. W. Foote $19,900, J. E. O'Brien and G. C. Arnold $100 each, and J. B. Mannix $500. J. B. Mannix as trustee holds twenty shares valued at $2,000. Object, to rebuild and equip the San Diego cable road with electricity.

Sacramento, Cal.—The Sacramento Electric, Gas and Railway Company. Capital stock, $2,500,000. The incorporators and first board of directors are: L. P. Drexler and Albert Gallatin, Jr., of San Francisco; Charles R. Lloyd of Oakland and J. W. Hall and L. T. Hatfield of Sacramento, and its object is to purchase all the property, rights, privileges and franchises of the Sacramento Electric Power and Light Company, also of the Folsom Water Power Company, and provision is made for engaging in all the various kinds of business heretofore engaged in by either of those companies, with authority to produce gas of different kinds, and all kinds of illuminants. It is understood that acetyline gas is the kind of gas in contemplation.

TRANSMISSION.

Mariposa, Cal.—There is nothing new reported about the Bend Power Company. There is some talk about another electrical power plant being started higher up on the Merced river some distance above the Benton Mills.

Stockton, Cal.—Charles Swain, of the famous Confidence mine, near Sonora, from which over $2,000,000 was taken prior to 1880, states that the company has under contemplation the installation of an electric plant for power purposes on the Tuolumne river four miles distant.

Salt Lake City, Utah.—The Garden City Electric Co. has submitted a proposition to the City Council offering to light the city at $8.50 per arc lamp per month, if a franchise be granted it, and the company proposes to transmit power from Provo River, forty-five miles distant.

Perris, Cal.—Prof. C. G. Baldwin of Pomona has acquired a water power in the San Bernardino mountains with which it is proposed to install an electric transmission plant for pumping water for irrigation purposes in Perris valley and for furnishing power for mines and manufactures.

Dixie, Idaho.—The Golden King Mining Co., recently incorporated with a capital of $1,000,000, has employed L. C. Trent of Salt Lake City to draft plans and specifications for a 100 h. p. electric power transmission plant, to be operated from the South Boyse River, five miles from the mine.

Riverside, Cal.—A shipment of 80,000 pounds of copper, 45,-000 pounds of which is of No. 4 bare wire has been received from the John A. Roeblings' Sons' Co. for the Riverside transmission. The work of installation is progressing satisfactorily and the plant will be in operation as promised.

City of Mexico, Mex.—The Nuevo Leon Legislature has authorized J. A. Robertson to erect a dam in the Poterero de Santa Catarina Canyon, on which must be spent $500,000 during the next five years, and the company is to have the right to use or sell the water for irrigation of power transmission purposes.

San Bernardino, Cal.—G. W. Fox, representing an Eastern syndicate states that his syndicate have purchased 744 acres in the Muscupiave Rancho, San Bernardino Co. for $100,000 and that the purchase includes 300 inches of water with more to be developed and a portion of which will be used for electric transmission purposes.

Sacramento, Cal.—The Central California Electric Co. has awarded the contract to the Westinghouse Electric and Manufacturing Co. for the installation of its proposed transmission plant from Newcastle to Sacramento. The sub-station will be located on Twelfth street, between E and F, and the operation of the plant by October is promised.

Santa Cruz, Cal.—The Big Creek Electric Power Co. have secured a franchise in this city, the consideration being $1000 and the free use of 10 arc lamps. The extension of the circuits of the Big Creek Co. to Alma, Los Gatos, Saratoga and San Jose, a distance of 24 miles, is under consideration. The pole line has been completed and the plant will be in operation early in June.

Riverside, Cal.—The city has paid to the Redlands Electric Light and Power Company $13,000 as the first installment on the new electric plant, and a large force of men are at work setting up poles and doing other work preparatory to lighting the city. The material is all on hand, and the work of placing it will be crowded ahead as rapidly as possible. It is expected that the plant will be in operation by August 1st.

LITIGATION.

Fairhaven, Wash.—The legal fight for possession of the Fairhaven and New Whatcom Street Railway is becoming more intense. The Superior Court appointed as receiver E. J. Hill, at the request of resident creditors of the company, and the American Trust Company, representing the Eastern bondholders, are dissatisfied, and now sue in the Federal Court for the appointment of Norman Tucker, their choice for receiver, who will protect the interests of the bondholders in

preference to local creditors. Already 13 answers have been filed to as many suits, and the end is not yet. The bonded indebtedness of the road upon which these suits are now founded amounts to $300,000. It is not believed that the road will bring above $100,000, and should the effort to foreclose result favorably to the bondholders, they would take this amount to the detriment of local creditors. The Fairhaven City Council at a recent meeting repealed the ordinance under which this company was given a franchise through the city, which action, it is alleged, was taken through sympathy for local creditors, and to impede the efforts of the electric company in their foreclosure proceedings.

San Francisco, Cal.—Judge Belcher of the Superior Court has handed down an opinion on the rights of stockholders to demand and examine corporation books. The opinion was in the case of the People vs. James Fisher, Secretary of the Mutual Electric Light Company. The defendant had been tried in the police court on a complaint made by George E. Whitaker, a stockholder who had been denied access to the company's books, and was fined $50.00. Judge Belcher, affirming the judgment of the lower court, says the right of inspection of a corporation's books by a stockholder "seems to be absolute in proper cases, even in the absence of legislation, and damages may be recovered for refusal." And the stockholder may inspect through his duly authorized agent or attorney. The right to inspect carried with it the right to make extracts and memoranda. Further, Judge Belcher says: "In California the stockholders have the same right as the members of an ordinary partnership to examine the books of their company at any time." Commenting upon the California statutes, the Judge says: "It seems to me that the statutes of this State giving stockholders the right to inspect the books of their companies, and providing a penalty for refusal, are highly beneficial in nature and should be liberally construed to effect the ends in view." The Judge says that if the books are in use at the time called for and the stockholder is asked to wait a reasonable, specified time, such a request to wait cannot be construed as a refusal.

San Francisco, Cal.—Superior Judge Seawell has refused to restrain Superintendent of Streets Ashworth by injunction from removing the lamp-posts erected on Market street by the Mutual Electric Light Company. The company was granted permission to lay conduits on Market street, between Kearny and Grant avenue. The permission carried with it the right to connect the conduits with business blocks on either side of the street, but the company went further and put up lamp-posts. Superintendent Ashworth ordered the removal of the posts, and the company obtained a temporary restraining order. In dissolving the injunction Judge Seawell said: "Anything which unlawfully obstructs the free passage or use in the customary manner of any public street or highway is a nuisance. The sidewalks of a public street are parts of the street. Any unlawful obstruction of a sidewalk is therefore a nuisance. The Board of Supervisors may authorize the erection of lamp-posts in order to light the city, and when so erected they cease to be a nuisance. The burden of showing that a particular obstruction has been placed in a street by lawful authority is on the plaintiff. The constitution provides that lighting corporations may under the supervision of the municipality lay pipes and conduits in the public streets and thoroughfares and make connections with them so far as may be necessary for supplying the city with light. Judge Seawell was of the opinion that the use granted did not extend to the erection of lamp-posts on the streets. He found that no such right was expressly granted, and he believed it the intention of the law to give to the municipality the exclusive right to regulate the manner of lighting public streets. The restraining order was therefore vacated."

TRANSPORTATION.

Phoenix, Ariz.—The Fowler Railroad franchise has been extended until April 9th, 1897.

Pasadena, Cal.—The line of the Pasadena and Pacific Railway Co. is now in operation to the Southern Pacific depot.

Long Beach, Cal.—An electric road to extend in almost a direct line southwest from Los Angeles to this city is being projected.

Berkeley, Cal.—Experiments are to be made with a gasoline motor on the horse car line running between East and West Berkeley.

Redlands, Cal.—F. A. Miller, Secretary of the Riverside and Arlington Railway Company, has secured permission to equip the line with electricity.

Santa Rosa, Cal.—It is probable that one or more of B. L. Ryder's compressed air motor cars will be placed on the line of the Central Street Railway Co.

San Luis Obispo, Cal.—J. L. Howard and E. Goodall have been granted a 29-year franchise for a single track railway on Marsh street from Essex to Johnson streets.

Stockton, Cal.—The Stockton Gas Light and Heat Co., operating the Stockton Electric Railway, has installed a new 150 h. p. 500-volt Westinghouse generator for operating its power circuits.

Salt Lake City, Utah.—The Board of Supervisors have accepted C. R. McKay's proposition for the installation of a Sprague-Pratt high duty elevator in the joint city and county building.

Portland, Or.—The use of the cable on the Portland Heights Incline is still continued, but it is being operated by a 125 h. p. 500-volt T. H. bi-polar motor, driven from the trolley circuit of the Portland Cable Railway Co.

Oakland, Cal.—The California Railway is now being operated as an electric line and standard trains are being hauled over it by electric locomotives of the Baltimore & Ohio types, carrying two G. E. 1200 equipments.

Redlands, Cal.—It is rumored that A. K. Smiley of Redlands will build an electric mountain railroad to Fradelba Park, the summer resort planned for him on the summit of the San Bernardino mountains. The enterprise will cost $175,000.

Santa Barbara, Cal.—Ten tons of trolley wire have been ordered by the Santa Barbara Consolidated Electric Railway Co., from the Washburn & Moen Manufacturing Co. Active building operations on the new line will begin not later than June 1st.

Stockton, Cal.—The purchase of the Stockton Street Railway system by the Stockton Gas, Light and Heat Company, is receiving the consideration of F. A. Hihn of Santa Cruz and Oliver Eldridge and Wm. J. Dutton of San Francisco, of the Gas Company's directory.

Santa Monica, Cal.—The line of the Santa Monica and Soldiers' Home Railway Company running to South Santa Monica is to be equipped with electricty and it is expected that power for the operation of the new line will be furnished by the Pasadena and Pacific Railway Company.

San Andreas, Cal.—Prince Poniatowski of the California Exploration Company has gone to London to secure capital for the development of the company's projects, among which are the building of a broad-guage electric road from San Andreas to Valley Springs, a distance of ten miles, where connection will be made with Lodi on the Sacramento and Stockton branch of the S. P. R. R.

San Diego, Cal.—The Citizens' Traction Co., organized by the owners of the San Diego Cable Road for converting the cable

line into an electric system, is rushing the work of reconstruction and expects to have the new line in operation by July 1st. General electric equipment is to be used throughout, and the plant will consist of 2 100 kw. multi-polar generators and six car equipments.

Kingman, Ariz.—A company is soon to be organized for building an electric railway in Mojave County to run from Kingman to the various mining camps hereabout. The first line will be built to White Hills and will carry freight and passengers. Among the mining camps to be reached by the proposed road are Cerbat, Mineral Park, Chloride, White Hills, Weaver, Minnesota and El Dorado Canyon.

Clovis, Cal.—W. R. Birmingham of Pollasky, who is manager for the Michigan Lumber Company, is reported as saying that the Eastern Lumber Company, which has a large belt of magnificent timber on the North Fork of the San Joaquin, in Madera county, will not build a flume to Pollasky as formerly intended, but will construct an electric railroad from their timber to Fresno. The company expects to get its motive power from the San Joaquin Electric Company.

Nevada City, Cal.—It is stated that Hon. John F. Kidder, who owns the franchise for an electric railroad between this place and Grass Valley, has about completed negotiations whereby the Nevada County Electric Power Company will come into possession of the franchise and build the road. It is understood that a company has been organized with $80,000 capital, and that the bulk of the stock is held by by the management of the Nevada County Electric Power Company, which incorporation is to supply the electricity necessary to operate the cars.

Alameda, Cal.—The extension of the Alameda, Oakland and Piedmont Electric Railway from Alameda to Laundry Farm is being actively pushed. This road will supersede the standard steam line known as the California Railway. The construction will be most substantial, and the new line will be the first to be equipped with the Nantasket trolley wire of Roebling manufacture. The road will be operated by a double end locomotive of the Baltimore and Ohio type. Alexander Flatland has resigned the electricianship of the Alameda line and Leon H. Wolf has been promoted to the vacancy.

Elmhurst, Cal.—The steam equipment of the Oakland, San Leandro and Haywards Electric Railyaw Co. consists of three Heine boilers of 150 h. p. each, run at 120 lbs., two tandem compound McIntosh & Seymour 150 h. p. engines, each 11½ x 19 x 15-inch stroke, and one tandem compound Ball 500 h. p. engine, 18 x 30 x 18-inch stroke, and Conover & Davidson jet condensers. The cooling pond is 60 feet square, contains 100,000 gallons of water and water leaving the condenser at 130 deg. runs 900 feet and is pumped at 90 deg. Four Thomson-Houston M. P. 90 and one General Electric M. P. 400 generators are used.

San Francisco, Cal.—The Market Street Railway Co. has extended the Ingleside line from the racetrack to the Ingleside House, and is now constructing the roadbed for the electric line on Folsom street. It is announced that the company intends to change the Howard, Post and Montgomery street lines to the electric system at an early day. Another portion of the Omnibus system which it is proposed to reconstruct is the horse-car line on Tenth street, from Howard to Potrero avenue. It is intended to lay a double track electric roadbed on Tenth street and form a connection with the Bryant and Brannan-street system and to connect the San Bruno road line with the Army street road, which was built by the old Beach and Mission Company four years ago, but never operated. The Army street tracks were laid from Folsom to San Bruno road and the roadbed is in readiness for the trolley cars, with the exception of the overhead work. The California Exploration Company has been organized for the development of various transmission railway and mining projects in California. E. H. Brandt has been appointed Chief Engineer, and the principal officers are: President, Charles E. Green, Secretary of the Crocker Estate Company; Vice President, N. P. Cowles; Secretary, C. Torson. Orders have been given for two Siemens-Halske 400 kw. railway generators to be directly coupled to triple expansion vertical engines, built by the Union Iron Works and for use in the Bryant street power house.

Los Angeles, Cal. The Los Angeles Consolidated Electric Co., has moved its offices from the power house to the corner of Sixth street and Wolfskill avenue. The stockholders of the Main street and Agricultural Park Railway, operating the mule line on Main and Jefferson streets and Wesley avenue to Agricultural Park have passed resolutions authorizing the issuance of $350,000 bonds to re-equip the line as an electric road. Certain Eastern capitalists are credited with believing that there is a field for an electric road from this city to Redondo, Long Beach and San Pedro and that having failed in their desire to buy the Redondo Railway they will parallel that system. The Los Angeles and Pasadena line has secured a franchise running from Shorb's station to Alhambra, Santa Anita and Monrovia. W. H. Workman has secured a franchise for an electric road to run from Stephenson avenue and Third street east to Santa Fe avenue, south to Short street, south to Fourth street on the east side of the river,east to Fourth to the corner of Boyle avenue, east on Fourth to Fresno, north on Fresno to First, to the eastern city limits; also a line commencing on Sixth and Hill streets, running east to Ceres avenue, and thence to Third street. Rumors prevail to the effect that the Los Angeles Traction Company will extend its line to Santa Monica. Abbot Kinney and associates have secured a large block of stock in the Mateo street and Santa Fe Avenue Street Car Co., and will probably displace the horse cars with electric service. The Ninth street line of the Los Angeles Railway Co., is now in operation.

ILLUMINATION.

Alameda, Cal.—The city is removing the poles set up by F. N. Delanoy's Electric Light Company.

Redondo, Cal.—H. J. Lindsay proposes to furnish this town with nine 2000-c. p. arc lamps for $100.00 per month.

Phoenix, Arizona.—Messrs. Copeland & McCallum have secured a franchise for an electric light works, water works and cold storage plant, and are already operating the electric plant from their machine shops.

Logan, Utah.—The City Council has granted a 40 year franchise to the Hercules Electric Power Co., in view of which and despite the fact that the city owns electric light and water works, bids for street lighting have been called for.

Mokelumne Hill, Cal.—W. T. Harris, Superintendent of the Roanoke Mining Co., has made satisfactory arrangements for the installation of an electric plant to furnish the Moser and Lamphere mines with power and Mokelumne Hill with lights.

Fort Bragg, Cal.—The City Trustees have accepted the proposition of the Union Lumber Co., to light the town with 40 incandescents for which $200 is to be paid before July 1st for wiring etc., the lamps to be operated at a monthly rental of $24.

Oakdale, Cal.—J. W. Tulloch of the Knights Ferry Electric Lighting Plant states that he is installing a dynamo in the Knights Ferry Fouring Mills to furnish light for this place.

The distance was 12 miles and the pole line construction is finished.

Oakland, Cal.—The street lighting committee of the City Council has recommended that bids for furnishing not more than 470 and not less than 420 electric lights for next year be called for. At present there are 420 electric lights in the city and 89 gas lights.

Anaheim, Cal.—The Board of Trustees of Anaheim has decided to call for municipal bonds in the amount of $18,000 for the purpose of improving the city water and electric light system. L. B. Pemberton of Los Angeles estimates that the electrical improvements will cost $7685.

Saucelito, Cal.—Jacob Strittmatter is erecting a power house, 26 by 60 feet, for the Saucelito Electric Light and Power Co.

Wheatland, Cal.—The Nickerson mine at the junction of Bear river and Wolf creek is being fitted up by an English company with electric lights, drills and power.

Yreka, Cal.—A competing electric light plant is promised and the party canvassing for the new company will extend the system to Montague over the telephone poles, if he receives sufficient encouragement. A plant will probably be put in at Pokegama, which has excellent water power.

Berkeley, Cal.—The Berkeley Electric Lighting Company is about to erect a new $20,000 electric station on its property at the corner of Third street and Channing way, West Berkeley. The station will have a total capacity of 400 horsepower and will be capable of supplying 5000 16-c. p. lamps.

Oakdale, Cal.—The Stanislaus Milling & Power Company has purchased an additional Westinghouse 35 kw. alternator to be placed in the Knight's Ferry plant for lighting this place. The distance of transmission will be 12 miles and it is expected that the plant will be in operation by April 15. Charles T. Telleck is Manager.

Vallejo, Cal.—The fact that Vallejo is without an electric light plant has drawn the attention of capitalists who are looking for a chance to invest, and it is probable that a new company will be organized shortly. The city of Vallejo has gone to the extent of its liabilities in constructing new water works, and could not also build electric light works.

Alameda, Cal.—The report of Chas. E. Naylor, expert made to the municipal ownership league has been rendered bases upon the warrant books for "the 100 months of ownership under favorable conditions." From the report it appears that the total cost of plant to date plus five per cent interest is $171,433.02 and that the net cost to date is $49,112.61. If interest is charged on the bonds issued amounting to $8,139 and not on the net cost, the net cost to date is $41,059.50. The loss and gain tabulation shows net profits amounting to $44,077.03 which is obtained by deducting $76,876.68 for expense and repairs from $120,953.71 the amount credited for lighting service. On the investment to date the estimate is $77,997.29 which with interest charge makes the total of $94,556.34. The inventory salutation of the property is fixed at $50,150.75 and the report shows that the net profit is $2,077.75. The expert declares that the plant can be made self supporting by increasing its capacity to 5,000 incandescent lamps.

The temporary injunction prayed for by J. T. Fleming restraining the City Trustees from making further expenditures towards extending the municipal lighting plant has been dissolved.

MISCELLANEOUS.

Sonora, Cal.—The owners of the Rawhide Mine are arranging to build an electro-plating works at the mine to be of sufficient capacity to do not only the work for the Rawhide and App mines, but all custom work as well. In addition to this improvement a new chlorination plant is to be built immediately, the present one of three tons capacity daily is only about one half large enough. They are now running three eight hour shifts on it in an endeavor to keep up with the output of sulphurets, but find it an impossible task. The electric power is being used to run the mill but not the hoist. As soon as larger motors can be brought here to take the place of those now in position, the whole plant will be run by electricity.

Sacramento, Cal.—On May 15th a superb special train conveyed a large party of influential men on an excursion from San Francisco to this city and Folsom, as guests of the General Electric Company of New York and the Sacramento Electric Light and Power Company, to inspect the plant of the latter concern.

The party consisted of representative business men, capitalists, bankers and well known men of affairs who are interested in utilizing electric power and studying the problems of its long-distance transmission. The guest of the day was General Manuel L. Barillas, ex-President of Guatemala, who is greatly interested in the development of electric power. Colonel N. P. Tisdell, special agent of the Pacific Mail Steamship Company for Central America; Pedro Bruni, manager of General Barillas' estates; Adolph Meyer, president of the Champerico Railway Company of Central America; Florentine Souza, a capitalist and coffee planter of Guatemala; C. A. Coffin, president of the General Electric Company; Serio Mine, Special Commissioner for the Japanese Government to the United States; W. H. Mills, William Angus, Joseph Brandenstein, John A. Britton, Frank L. Brown, S. C. Bigelow, J. B. Crockett, president of the San Francisco Gas Company; W. S. Goodfellow, Bruce Hayden, John L. Howard, C. G. Hooker, E. C. Jones, William Sanders, president of the Oakland, San Leandro and Haywards Railroad; J. A. Lighthipe, engineer for the General Electric Company; Daniel Meyer, H. W. Meek, D. E. Martin, George A. Moore, president of the Pacific Mutual Life Insurance Company; E. B. Pond, ex-Mayor of San Francisco; W. F. Perkins, W. F. Rank, James B. Stetson, president of the San Joaquin and Valley Railroad; F. W. Van Secklen, Fred P. Fish of New York, attorney for the General Electric Railway Company; R. P. Schwerin, vice president and general manager of the Pacific Mail Steamship Company; Captain John T. Wright, T. L. Barker, Dr. Thomas Addison, Pacific manager of the General Electric Company; L. P. Drexler, Charles R. Lloyd, C. N. Beall, engineer of the Bakersfield Electric Power Company; J. K. Wilson, president of the Sather Banking Company; M. H. De Young of the San Francisco "Chronicle;" C. C. Bemis, J. S. Hutchinson, A. Carrigan, William G. Kerckhoff, I. F. Moulton of the Bank of California; F. L. Lipman, G. F. Richardson, master of transportation Southern Pacific Company; Thomas B. Bishop, John I. Sabin, president of the Bell Telephone Company; Charles A. Hugg of Spreckels Brothers, W. H. Chickering, A. C. Balch, W. F. Pierce, ex-Mayor of Oakland; James Treadwell of the Corral Hollow coal mine property.

From Sacramento there were Frederick Cox, president California State Bank; W. E. Gerber, cashier California State Bank; Joseph Steffens, president, and George B. Katzenstein, secretary, of the Chamber of Commerce; C. H. Hubbard, Mayor of Sacramento; J. A. Woodson, V. S. McClatchy, Jabez Turner, ex-Mayor of Sacramento; J. N. Larkin, E. K. Alsip, A. A. Von Voorhies, G. M. Mott, E. C. Rutherford.

The special hosts managing were Albert Gallatin, president Sacramento Electric Light and Power Company; H. P. and Charles E. Livermore of the same company; Manager Hall and Superintendent Shock of the same company; Dr. Thomas Addison, of the General Electric Company; and Joshua Barker, secretary of the Sacramento company.

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Destruction of the Union Power Plant

The electrical fraternity will regret to learn that the power plant of the Union Power Company, of Portland, Or., which was the first to apply the Edison three-wire system for the transmission of power for the operation of street railways located at considerable distance from the power house, was burned on June 8th, and the completeness of the destructions is clearly shown in the accompanying reproductions of photographs of the ruin. The fire occurred about 4 a. m., shortly before the usual time for the plant to be fired up for the day's run, and from all evidence obtainable it is believed that the fire originated from sparks which found their way from one of the furnaces into the open air through a defective sawdust conveyer, whence it lodged on the frame partition separating the boiler from the engine and generator rooms, probably igniting the fine sawdust flour that had settled on the timbers and developing into flames that quickly enveloped the whole structure. Only the engine and countershafting foundations were of concrete.

The site of the power house was on low bottom lands at the extreme north end of the City of Portland, and at the time of the fire the June rise of the Columbia River had backed up the water of the Willamette so that this bottom land was covered to a depth of about three feet. The boilers and generators were supported on piling reinforced by wood piers resting on concrete foundations and the fearful wreck formed by the boilers, stacks, breechings and fronts with their sittings and fittings, points to the wisdom of providing suitable foundations capable of supporting the boilers through any fire. The building itself was of substantial frame construction, and the floors being thoroughly oil-soaked, the fire was an extremely hot one. Despite this, however, the 18x18 inch timbers supporting the generators were not sufficiently burned to cause the generators to fall into the water, but their tottering condition rendered it necessary that they should be loaded on barges and docked so that an examination of the machines might be made with safety.

FIGURE 1.—A STUDY OF A BURNED RAILWAY GENERATOR

The equipment of the Union Power Company consisted of ten steel boilers, each 60 inches by 16 feet in size, and so connected that they might be operated separately or together. There were two engines, one a Fraser & Chalmers cross compound of 1200 horse power, formerly used for a brief time in one of the Los

Angeles cable roads, and the other a Buckeye automatic of 500 horse power. Rope transmission was used throughout, and the engines, belted to a countershaft extending the width of the station, transmitted power thence for the operation of seven 150 kilowatt Edison bi-polar railway generators.

The switchboard was equipped with Edison ammeters, Thomson wattmeters, Weston voltmeters and Westinghouse marble base circuit breakers, and its most interesting feature rested in the fact, as stated,

FIGURE 2.—SAWDUST CONVEYOR BETWEEN THE NORTH PACIFIC LUMBER MILLS AND THE UNION POWER PLANT

that it distributed power on the Edison three-wire system. The plant was located probably two miles from a railway center, whence current was fed positive to one system and negative to the other, using the ground for a neutral, and the company, by adopting this distribution, effected a saving of about $11,000 in copper. Sawdust fuel was obtained from the saw mill of the North Pacific Lumber Company, situated about 1500 feet north of the power house, and the sawdust was conveyed from the mill to the plant by means of the long conveyer and dumping carriage shown in Figure 2. Except for the loading of the conveyer cars, which was done by hand, the operation of the conveyer was entirely automatic. The sawdust was dumped into the sawdust house of the plant, now burned, whence it was taken by a smaller boiler conveyer and automatically fed to the boilers. It was owing to a defect in this boiler conveyor, as stated, that the fire originated. The steam plant was equipped with jet condensers operated by two Hall pumps, and was in every way fitted for producing steam power at low cost.

The experience derived in the appraisement of the value of the burned generators developed several interesting points. The dynamos were installed early in the summer of 1892. They are no longer listed for sale as standard apparatus, but can be made by the General Electric Company on special order. Upon their investigations, the appraisers agreed that the depreciation to these machines from advances in the art of dynamo building alone, amounted to ten per cent per annum. The appraisers were unable to find a Pacific Coast market for the wrought iron parts of the generators owing to the fact that the pieces, which weighed from 3,900 to 5,500 pounds each, could not be handled to advantage by any rolling mill on the Pacific Coast. The melting of the zinc bases threw the entire weight of the fields upon the armature shafts, which being heated, caused the shafts to be sprung so seriously as to unfit them for further duty. All of the bed plates were ruined either by cracking or by having been so heated as to cause them to sag. Physically the field circuits were unimpaired, which is undoubtedly due to the fact that the keepers, cores and pole pieces were so massive as to withstand the heat. The manner in which the pulleys were ruined is peculiar in that in each instance the break which occurred appeared to be due to the lightness of the rim which caused it to expand more quickly in the heat than the spokes, and so rapid was its heating and expansion that the rims pulled away from the spokes, leaving cracks that when cold varied from one-thirty-second to thirty-three-seconds of an inch in width entirely around the junction between the spoke and the rim. No information was gathered concerning the permeability of the magnetic field circuit, and opinions vary materially as to the effects which fire will exert on the efficiency of machines. In brief, it was concluded after a thorough examination of all parts of the generators, that it would be impracticable under the circumstances to rebuild them.

Two years ago the Union Power plant was submerged by the unprecedented flood of the Columbia River, and these generators remained under water for two weeks or more. The most approved means were used for drying out the armatures, but with one excep-

FIGURE 3.—A PARTIAL VIEW OF THE RUINS

tion the armatures burned out after brief runs; the armature which withstood the flood being one that had been rewound and in which the thinnest asbestos paper had been used for insulation.

In January last the plant of the Union Power Company was leased to the Portland General Electric Company, since which time it has been operated in conjunction with the rotary transformers driven by three-

phase power transmitted from Oregon City. Upon the burning of the Union Power plant the reserve steam plant of the Portland General Electric Company at the Inman & Paulson mill has been started up and power has been furnished to the street railway and power circuits of Portland practically without interruption since the fire. The Oregon City circuits and rotary transformers are, however, heavily loaded, but as yet it has

FIGURE 4.—THE 1000 HORSE POWER ENGINE—AN ILLUSTRATION OF THE VALUE OF GOOD FOUNDATIONS

not been determined whether the plant of the Union Power Company will be rebuilt, or whether the transmission plant will be enlarged.

GENIUS NOT UNAPPRECIATED.

"B," who advertised for a position in the last number of the Journal, will be gratified to know that his qualifications are appreciated, at least in one quarter, as the following letter shows:

SAN FRANCISCO, Cal.

Editor Journal of Electricity.

Sir: Fearing to lose the services of the prodigy mentioned in your last issue under the head of "Don't All Speak at Once." I write this at midnight on receiving your welcome paper. I fully realize that such a man will not long grace the ranks of the unemployed, nor would he accept a low salary, so kindly put me in communication with him at once, as I am afraid to lose his services.

His letter brings to mind a similar one received by the company I represent and we sought for him far and wide, as we desired a first-class cornetist to play solos to our slow speed motors. We have only a small window, but we desire an A1 designer to artistically arrange three or four Cleveland motors, 1887 model, therein. Kindly inquire if he can analyze our motor lubricant as we are afraid it is not correctly mixed. We are also thinking of buying Battery A of the Presidio, and as he is a tip-top battery man his services will be appreciated by us. Kindly inquire also if slow speed motors run any cooler or better if supplied with music from an A flat or a B flat cornet. Perhaps we would be fortunate enough to secure a good baritone, as the company's choir is not yet full.

Taken all in all, such a man would be invaluable to us, and we would not be surprised if he were snapped up by some rival corporation. Don't delay. Answer at once.

PACIFIC MOTOR CO.,
By W. A. HENRY, Manager.

Pneumatics

EFFICIENCIES OF AN AIR TRANSMISSION PLANT.*

BY ALLEN DE WITT FOOTE

Upon the prohibition of placer mining by the State of California, the immense canal systems extending over the Western slopes of the Sierra Nevadas were left without a purpose, and their future existence depended upon a new use for water. Out of this necessity has grown a business of selling water for power and irrigation, retaining the original methods of delivery at the bank of the canal and miners' inch measurement. The price of water is approximately 1 cent per 1000 gallons, delivered at the canal; its cost for power depends upon the pressure that can be obtained from it. In the case of the North Star plant it could have been conveyed directly to the mines and have done its work there on different wheels more or less adapted to the varying conditions; but there is a certain inconvenience and danger in using water in this manner under a high pressure, and, moreover, the mines are on a hill. So it seemed advisable to convey the water directly to the lowest convenient point, obtain the power there and transmit this power to the places where it was needed.

This brought forward the subject of transmission of power, and electricity was naturally suggested first. Visits to mines in operation and careful study and investigation of electrical appliances for underground

FIGURE 4—AMID THE RUINS OF THE UNION POWER PLANT

work, especially pumping, finally decided the author in favor of compressed air. The latter method, under the conditions, was believed to be most economical of power, least liable to accident, and cheapest in first cost. Moreover, almost absolute security against stoppage

* Abstract of a paper read before the San Francisco Convention of the American Society of Civil Engineers. (For more complete description of the air compressors, the Cobb Water Wheel and the pumping equipment of the North Star Mining Plant, see the issues of this publication for November 1895 and May 1896.—EDS.)

could be obtained by having a set of boilers on hand ready for firing up in case the water power or air plant gave out, for, by the use of these boilers and opening and shutting a few valves, all the air motors become equally good steam motors; whereas, with electrical transmission an entire set of steam motors would have to be provided to give equal security; or, as the air and steam motors are the same, the electrical motors would require just so much extra expense in cost of plant of equal security against stoppage.

The water supply is obtained from the South Yuba Water Company at a point on their canal about four miles from Grass Valley, in Nevada County, Cal. Thence it is conveyed about two and one-half miles to the Empire Mining Company's works in a 22-inch riveted iron pipe, built more than ten years ago. The new conduit is a riveted steel pipe, 20 inches in diameter, joined to the lower end of this old one under a head of 420 feet, and continues 7070 feet to the power-house, situated at the lowest convenient point on Wolf Creek, just below the town of Grass Valley, where a head of 775 feet, or a static pressure of 335 pounds per square inch, is obtained. The capacity of this pipe is sufficient

FIGURE 6.—A GROUP OF BURNED GENERATORS

to develop 800 to 1000 horse-power. A 6-inch lap-welded pipe conveys the air at 90 pounds pressure from the power-house to the company's Stockbridge shaft on Massachusetts Hill, 800 feet distant and 125 feet higher.

The line of the pipe is quite crooked, both horizontally and vertically and the joint holes cost fully as much as the trench. The latter was about 10 feet wide on top, 45 feet on the bottom and 4 feet deep, and the joint holes were 45 feet long and 3 feet deeper than the trench. The total cost of burying the pipe, including covering a large portion of it with stone, and cement masonry wells for the valves and sustaining the pipe around bends, amounted to $6,756.27. The aqueduct of cement masonry across Wolf Creek contains the pipe and had three arches, the length over all being 153 feet. It cost $1,435, or about $8 per yard. The pipe was made from 48x66-inch sheets, and laid complete in lengths of about 28 feet in the trench under the following schedule, the longitudinal seams being double rivited by hydraulic riveters:

Head in Ft.	Length.	No. B.W G.	Thickness.	Rivets.	Remarks.
420 to 500	2,320 ft.	9	0.148 in.	⅜ in.	cold rivited.
500 to 600	2,110 ft. 6 in.	8	0.165 in.	⅜ in.	"
600 to 700	1,158 ft.	7	0.180 in.	7-16 in.	"
700 to 750	1,204 ft.	6	0.203 in.	½ in.	hot rivited.
750 to 775	285 ft.	5	0.220 in.	½ in.	"
Receiver.	40 ft.	....	0.375 in.	9-16 in.	"

The specifications required a mild and very tough steel and the cold flat bending test was insisted upon for all thicknesses. The pipe was dipped into the usual hot asphaltum mixture. Where there was no change in direction a slip joint was made by raising the outer end of the link with a small hand derrick, slipping the upper side into the completed portion and catching it there through the rivet holes with bolts. Then by lowering the outer end the weight forced the length into its place with a little care and guidance by chisels, when it was bolted for the riveters. P & B paint was used to cover all points not protected by the original asphaltum mixture because it was considered preferable to the hot mixture when put on the cold metal.

Numerous very small leaks appeared in the pipe under pressure, but neither then nor since then has there been a defective rivet or plate. Fine dust from the wagon road was put into the pipe in considerable quantities, which stopped most of the smaller leaks or sweating. The attempt was made at first to mark the larger leaks and then take off the pressure and calk them as in the case of a steam boiler, but the leak would appear again as soon as the pressure was returned. Since the leaks have been calked under pressure using proper care not to strike heavy blows, all troubles ceased. Close watching was necessary, however, as a stream no larger than a hair, if it happened to be turned along or against the pipe, would, with the aid of the sand it washed in, cut the pipe badly in a few hours. In one instance, two threads of water so small that they failed to wet the earth upward to the surface, shot out at right angles to each other and striking each other formed a miniature whirlpool which bored a hole through the pipe about the size and shape of the point of a lead pencil letting out a larger stream, which soon led to its discovery.

At the lower end of the pipe in the power house is a 20-inch gate, below which is a 12-inch branch leading to the 18-foot Pelton wheel and adjoining this is the receiver two feet in diameter on which are the air chambers, charging tube and release valve. The air chamber is a 10-inch lap-welded tube, 18 feet long standing on the receiver with an 8-inch gate between. The charging tube is similar, but 8 inches diameter. Both have 2-inch water discharge pipes and gates, and by proper manipulation of the gates and the operation of inlet check valve on top of the tubes, the air chamber may be filled. Ordinarily the charging tube is filled up to 90 lbs. pressure from the air compressor delivery

pipe, and then raised by the water pressure. It is found necessary to put in about one-tenth of the volume of the air chamber every day. Where the air goes is thus far a mystery, as no leak has been discovered.

The relief valve was designed by Mr. H. Schussler, Chief Engineer of the Spring Valley Water Works of San Francisco, and is the first of its kind ever made. It seems perfect for the purpose, except that the small pop-valve leaks continually, but it is hoped that this fault may be remedied by using a different form of valve. It can be set to open at about 35 lbs. above normal, and will close without jar or hammer. In action, the pressure rises until it lifts a pop-valve in the ordinary way, when this is raised the pressure is relieved on top of an 8-inch piston, slightly larger at the top end, which rises and opens the ports of a 9-inch outlet. The pressure going down, the pop-valve closes and equalizes the pressure on both ends of the piston, gradually closing it. If the proper pop-valve can be procured, this relief valve will prove a sure safeguard for the pipe. On one occasion already, when from some unknown source a piece of drift wood entered the nozzle and stopped the flow of water instantly this relief valve saved the pipe from serious shock if not actual bursting..

The demand for direct action under a head of 775 feet made a large wheel necessary in order to obtain the proper peripheral speed of half the spouting velocity and the proper speed of 60 to 70 revolutions for the compressors required a wheel of nearly 30 feet in diameter. A wheel 18 feet 6 inches in diameter driving the compressor at 110 r. p. m. was finally built from a design by Mr. E. S. Cobb. Had the design been prepared sooner the wheel could have been made 30 feet in diameter equally as well. The Pelton Water Wheel Co. guaranteed an efficiency of 85 per cent at full load and an average of 75 per cent. from half to full load of the theoretical power of the water and to so govern the wheel that it should not exceed 120 revolutions nor raise the air pressure to above 105 lbs.

The regulator is a floating valve actuated against excessive velocity by the ordinary ball governor and against excessive air pressure by a spring set to move when the air pressure in the delivery pipe exceeds 90 lbs. This floating valve admits water on either end of a hydraulic piston which operates a lever moving a hood up and down over the head of the nozzle as the air pressure becomes too great or the speed gets above or below 110 revolutions. This regulator has now operated the wheel for several weeks and seems almost human in handling its speed. The load can be thrown off entirely and the governor will hold the wheel to 120 revolutions or less and if all the air motors happen to shut down the air pressure will increase rapidly and the wheel will slow down until at 110 lbs. it will stop.

The compressors are arranged to admit of being run at one-quarter, one-half, three-quarters or full load, hence it was quite an object to have a water wheel which would give as nearly as possible the full efficiency under these different loads. For this purpose there are four nozzles, one for each of the heads required, and these are changed with the load. It was of considerable interest to know the efficiency of so large a wheel and as it was necessary to measure the water quite accurately for business purposes a measuring flume 18 ft. long and 6 ft. 9 in. wide was constructed to take the tail water on leaving the building. The overflow was a sharp edged iron about 3 in. high and 15 in. above the bottom of the flume. No contractions were made. An 8-in. pipe about 6 ft. above the overflow connected with the gauge box within which was the measuring scale for the hooked gauge. The apparatus was made as perfect as possible and it is believed that the average result is within 1 per cent. of being correct. The power developed by the wheel was found by taking a large number of indicator cards from the compressor. These were averaged and the friction added, the latter being found by first running one compressor and afterward running it with the other compressor with the valves out; the difference in the quantity of water used was measured and the horse power of this water was called two-thirds of the friction of the machine when loaded, which was equivalent to allowing 50 per cent. for load. The friction of the water wheel and its bearings is included in its efficiency. Repeated tests which check very closely gave the wheel an efficiency of a trifle over 90 per cent. for one-quarter, one-half, three-quarters and full load.

Actual working has shown that this wheel has great efficiency at low speed; it began working using the half load nozzle and gradually, in pumping out the mine as the pumps were lowered and more power was needed, the limit of the machine while running one compressor at 110 to 115 revolutions was reached and the opposite compressor was connected on, the intention being to run three-quarters load with a three-quarters nozzle. As an experiment, both compressors were connected as if for full load and the half load nozzle was retained. The result showed considerable more power with both compressors running at 54 to 65 r. p. m. than was obtained with one compressor at 115 to 120, so much so indeed, that the works were kept running over two weeks longer with the half load nozzle, though the pumps were lowered on an average of 18 inches per day. Of course a large portion of the gain in power can be attributed to the saving in friction and improved working of the compressors under the slow motion, but yet it must be true that the wheel loses very little in its efficiency, compared with the accepted ideas of loss in wheel efficiencies working under a peripheral speed of one-quarter or the spouting velocity.

From the compressors the air is conveyed to the works at the mine, a distance of about 800 feet at a pressure of from 90 to 100 pounds. The transmission pipe is ordinary well tubing, $5\frac{3}{4}$ inches in diameter inside, screwed together in the trench and bent to fit the

(Continued on Page 134.)

THE JOURNAL OF ELECTRICITY.

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EDITED BY
F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

THE NATIONAL SCHOOL IGNOMINY

The Main Office of the National School of Electricity has been taken in charge by the sheriff on account of a confessed judgment amounting to more than $7000, and it is supposed that this must be the opening of the closing chapter in the history of that organization. It will be remembered that during the fall of last year we noticed the establishment of classes belonging to the National School in San Francisco, Sacramento and Los Angeles, and that our comment at the time was mainly favorable to the scheme; though some doubts were expressed concerning the efficiency of the management on account of charges that had been brought against it by well informed electrical papers of the East.

At that time there did not seem to be any reason for expecting this ignominious failure as the school was reported to have a membership of about four thousand which would represent an income of not less than $80,000. As the expenses of the school should have been small, there seems to be no satisfactory explanation of this ending unless the management be directly charged with dishonest practices. Such a conclusion appears to be borne out by the treatment of its instructors and classes on the Pacific Coast, for in no case has an instructor been paid more than the first installment of his salary and no apparatus has been furnished beyond that necessary for illustrating the first half dozen lessons, although the payments of almost all the scholars have been promptly made and forwarded to the home office. The total membership of the classes on the Pacific Coast amounted to more than 125, and we see that the National School of Electricity has deliberately taken from poor young men of the Pacific Coast over $2,500, and, but for the faithfulness of the instructors in charge of the classes, it would have given absolutely no return for this money. As the matter stands the instructors have done the best work in their ability under the circumstances, in spite of the lack of apparatus and no salary payments. This record of dishonesty could only have been made through the aid of the co-operation given in the aims of the school by a number of the best educators in the country, whose names have appeared as members of the honorary faculty, and who cannot be suspected of any cognizance of its dishonest methods. The plan was from the first seen to be a good one, and there was surely no reason for financial failure, had the ordinary principles of business honesty actuated its management.

For the unfortunate scholars and teachers there will probably be found no redress, as the property of the school cannot amount to anything appreciable, though the extensive inauguration of its plan of teaching will undoubtedly be followed by the establishment of many similar classes with a consequent gain to the community, in spite of the hardships the experiment has entailed upon individuals.

WHERE DOES THE TROUBLE LIE?

In the volumes of the Transactions of the American Institute of Electrical Engineers for 1895, we notice but a single article from any member on the Pacific Coast, and this one only amounting to a contributed discussion on the Storage Battery question. Surely more than twenty members covering a distinct section of the United States where are to be found many new electrical problems and new solutions of old problems, should have brought forth more scientific fruit than but a single article published in the Institute transactions. Two years ago there was a strong effort to establish local meetings of the Institute members, and during the winter before last several interesting meetings were held, the attendance at which showed a decided disposition towards increase, but though a local secretary was appointed for the Pacific Coast and one of the vice-presidents now resides in San Francisco, and though the single meeting held during the past winter was one of interest, the efforts for gathering the Institute members together and having the problems of the Pacific Coast presented by local engineers seems to have been altogether lost sight of. We think that we have shown by the articles we have published during the past year that there is ability to present engineering problems from an engineering point of view, and also that the undertakings of the electrical companies on the Pacific Coast cannot be properly presented by far-away engineers who derive their sole information from articles inspired by "Bureaus of Information." The policy of the Institute in the past has not been one to foster the preparation of papers far away from the central meeting place, but with local officers scattered through the country a new disposition on the part of the Institute is apparent, and we believe that strong efforts should be made by local

engineers to show that this change of policy is capable of bringing with it more varied opinions and scientific discussions and scientific papers from new hands.

The Institute membership is not large here, but so far as it goes it stands for good engineering ability, which will obtain greater recognition from the business men of the Coast by any means it can take for strengthening the local organization, and this cannot be done better than by returning to the plan formed two years ago of holding local meetings and endeavoring to bring out at these meetings papers which might ultimately be presented at New York and attract attention to the whole local body.

AIR FOR TRACTION PURPOSES

The New York dailies have been recently filled with articles on the compressed air motor and its availability for traction on surface tram roads, announcements being made that the Metropolitan Traction Company, operating the Broadway, Eighth and Tenth Avenue lines and the Third Avenue Railroad, operating a large cable system, are about to make extensive experiments with these motors and completely equips their lines thereby should the experiments prove a financial success. Both of these lines have within the last four years put down the most complete cable construction that has ever been installed in this country, and it has often been predicted, since they first used the cable, that they would one or both soon abandon it in favor of electric traction, but although the Third Avenue Company spent several hundred thousand dollars in a power plant and experiments with storage battery traction, and though the Metropolitan Traction Company has been operating its Lenox Avenue line on an underground trolley system, the results obtained up to the present have not warranted the introduction of electricity.

This seems hard to understand when we see in many large cities electric lines in successful operation and paying satisfactory dividends; but a comparison of the problem with that in any other city discloses at once certain special conditions that have not been met by electric traction. The streets of New York are not wide, and are much more crowded than those of any other city in the Union, the traffic over these streets requires the cars to be run on the Third Avenue and Broadway lines up to a maximum of eighty per hour, which is not reached in any other system, while the blocks due to drays and wagons are much more frequent than those of other cities. All of these conditions require a special solution of the tram road problem and this solution is not presented by electric traction. In Brooklyn, which is a city where the conditions greatly resemble those of New York, the accidents since the introduction of electric traction have been something appalling. In Chicago, where heavily loaded cable roads exist, an efficiency has been obtained of more than 80 per cent. of the total power of the generating station, applied to hauling cars. This is not appraehed by any electric railroad system. At the same time the cable does not give enough flexibility to overcome forced stoppages at the time of frequent blockades, and in consequence the management of these roads are searching for a new motive power; not so much for apparatus to increase the financial economy or safety of the system as to obtain a greater flexibility which will allow variable rates of speed and extensions of their lines without, at the same time, sacrificing too much efficiency. It is now believed that they will be able to obtain this by the introduction of compressed air motors.

More than twenty years ago compressed air was used experimentally on some of the New York lines, but at that time the machinery was not well enough developed nor was the problem of rapid transit sufficienty important to warrant its introduction. The engineers who designed the motors of that day have been working upon the problem ever since, and we notice prominently amongst the inventors now installing their motors the name of Hardie, whose system was tried long ago. In Worcester, Mass., compressed air seems to have proved a financial success, and in several cities in France the system has firmly established itself. Now that compressed air has been successful in solving certain long-distance transmission problems to mines on this Coast, we are naturally sanguine concerning the tram road experiments being carried on as we have described in New York.

Electricity has nothing to fear from the success of this means of furnishing motive power and of transmitting power, but we should hail the success of compressed air as another wonderful agent placed in the hands of engineers for the solution of commercial problems.

LORD KELVIN'S ANNIVERSARY

The celebration at Glasgow of the fiftieth anniversary of Lord Kelvin's occupance of a professional chair in that University has attracted the attention of scientific men throughout the world, nor is this to be wondered at when we consider the position of Lord Kelvin amongst practical men and electrical engineers as well as amongst theoretical physicists, and when we consider the advances in the science to which he has devoted the principal part of his attention during the period through which he has occupied the chair. More than all, however, the good will of the whole scientific world goes out to Lord Kelvin at this time on account of the personality of the man. No one who has ever seen this grand scientist has failed to feel the spell of his presence, and to watch his kindly smile. To observe his high scientific enthusiasm is of itself an inspiration to younger men. No one who has ever looked on his face could doubt for a moment that in him laid the power more valuable even than his own power of thinking—the power to make others bold to think. No young man ever came before this most gifted man during his long ser-

vice as a teacher, but went away with something more than lessons alone to remember. It has never been his custom to dampen scientific enthusiasm, but rather to build it up and direct it towards a complete scientific accomplishment.

It is hardly necessary in any part of the world to draw attention in particular to the manifold advances he has made in electricity. To Lord Kelvin we owe the best of our laboratory apparatus used in exact measurement, apparatus which from his first electrometer to his last current balance, shows a power of invention in both scientific and mechanical detail of the very highest order. The submarine telegraphs of the world owe to Lord Kelvin and to Faraday the scientific faith in their possibility which brought with it the faith of business men and enabled their accomplishment. His inventive ability made possible the safe construction of the submarine telegraph lines, and to that same ability we owe their satisfactory manipulation and commercial success. All the time that his work has shown so wonderful a genius as an inventor it has also shown his depth as a thinker and as a mathamatician.

It seems to us that more than all the world, the American electrical engineer should offer his homage to Lord Kelvin at this time, for to his genius we owe the mathematical investigations of the science which has rendered our greatest achievements possible, and through the impetus he has given to mathematical electricity do we owe the type of mind which renders our workers at once mechanics and students of a high order.

Passing Comment

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

THE HONESTY OF ENGINEERING SCHOOLS.

In the May and June numbers of the "Engineering Magazine" there have been discussion concerning the honesty of engineering schools, taking into account the educational value of their equipments, the alluring statements of their catalogues, the prospects held out by the instructors to new students, and the business connections of engineering teachers. The discussion was begun by Prof. Edgar Kidwell of the Michigan Mining School, at Houghton, Mich., in an article where he condemns not only the methods of our existing schools, but also imputes dishonest intentions to their managements. The article has been replied to by four different instructors, whose letters are printed in the June Magazine, and though exceptions have been taken to Professor Kidwell's manner of statement and to some of his conclusions, the general impression one would gather from the discussion is that there exists at the present time a well founded objection to many of the educational practices of our engineering professors.

We have already called attention to one phase of this discussion in an editorial which was called forth by the announcement that two at least of the professors of electrical engineering had formed business partnerships for the manufacture of machinery. At the time we stated that while an engineering professor could honestly indulge in professional consultation, it was not reasonable for him to expect information concerning the details of apparatus from manufacturers when at the same time he was a competitor of his informants.

The discussion above referred to has confirmed the opinion already expressed, and we deem it a healthy sign that there should be expressed by more than one educator a dissatisfaction with many of our existing methods; we would hardly agree that an engineering professor should be debarred from all business connections since only by being practically involved in works can he obtain the intimate details which concern closely his professional studies. Indeed, in one of the English technical schools, no teacher is admitted who is not doing professional work. It is, of course, a foregone conclusion that this professional work should be but second to his teaching employment, and as we have already stated, only such professional work should be indulged in as will increase his fund of knowledge available for educational purposes.

As regards the other questions of equipment, advertisements and inducements to scholars, we must certainly agree with much that has been said in condemnation of existing methods. It is not possible in a school to educate finished mechanics, and where such representations are made by the catalogue, by the equipment or by the professors, the charge of dishonesty can be sustained. Neither can the finished engineer be graduated from any institution or from any educational course, be it long or short, but the teaching in an engineering school may be easily such as will fit a man to make the best use of his future opportunities, the best use of his ability, and to become, after an apprenticeship of practice, an engineer in the true sense of the word. The school which does this is not necessarily the one making the most promises and publishing the most papers or equipped with the most elaborate machinery, but is one where the underlying principles of engineering education and practice are taught. The attempt to keep an engineering school abreast with the most recent engineering practice as regards machinery is foolish and wasteful of money, since the engineer does not learn methods of measurement or of judgment from the character of machines, but he may form habits of accuracy and care in measurement from required accuracy in the application of testing methods. The work done by advanced students in testing and the publicity given to college tests should not be underestimated, but these things are aside from elementary engineering education, and should not be confused either by the teacher or by the student. Where a man begins such tests he has begun the practice of his profession, and in a sense his engineering education may be considered already completed, for post graduate study is not the work of one or two years at an engineering

school, but should be the work of a lifetime, and whether one or two years of this study are carried on within college walls matters but little; the work is valuable to the student and valuable to the world at large. We are thankful for great equipments which enable it to be pursued to the best advantage, though the engineering school incapable of such work should not be condemned, but rather we must consider that the opportunities offered for undergraduate scholars are not limited by a lack of such equipment.

The quackery, then, does not lie in a great equipment or in great possibilities for deep work, but in the representations that such work is the work of the undergraduate student and not of the man already beginning his engineering career.

ELECTRICAL HEATING IN PRACTICE.

Mr. Fred De Land, writing for the June number of Electrical Engineering, has called attention in his notes of the Electrical Exposition at New York to the electrical heating apparatus there exhibited, and indeed the presence of so many forms of practical electric heating apparatus has apparently settled the dispute of many years concerning the possible usefulness of such a means of heating. There is no doubt but that heating by electricity cannot give the same efficiency, when the total quantities of heat developed are compared, as can be obtained by direct coal heating. Although the efficiency of electric heating apparatus is very high, the consumption of coal is that which is necessary for producing the current required, and when we include all the losses in our reckoning, we find that the total heat cannot be the same as that obtained from the crudest stove; but, on the other hand, the heat available from a stove is not often a large proportion of the total amount of heat developed in the fire, and furthermore the cost may often be a function of the manner in which the heat is furnished, as well as of the amount of heat used.

Let us explain this by a simple example taken from laundry practice. Of the total heat developed by a laundry stove a large proportion is given to the air of the room, by the stove and by the irons themselves after they are put into use, and in consequence the temperature of the room is often oppressive to the operatives, while it is impossible to maintain the irons at a proper temperature for more than a few minutes. As a result, the operators are working at their maximum efficiency for little of the time. Should the iron be too hot, there is danger of destroying the fabrics worked upon, while after the iron has cooled the operator must employ an increased amount of pressure. With an electric iron a given temperature can be maintained indefinitely, and in consequence it is found that the efficiency of the operator using the iron is increased from 35 to 40 per cent, while the temperature of the work-room is materially reduced on account of the absence of the stove. Similarly, glue and pitch pots can be easily maintained at any temperature by this means of heating. For cooking, the great efficiency of the apparatus lies in the possibility of using the current for only such time as the operation of heating is carried on, and for such operations as this electric heating has proved its success, though it is doubtful whether it is possible to install economical electrical apparatus for warming buildings or for any other purpose where a continuous fire may be economically employed.

A NEW ROTARY TRANSFORMER SYSTEM.

One of the most remarkable of recent inventions connected with electrical distribution is the system of alternate current distribution recently developed by Professors Ferraris and Arnot of Turin, Italy, a description of which, translated from L'Electricita, a descripfound in the Electrical Engineer of June 3rd. Reasoning from the action of the various circuits in an induction motor, it was seen that if a two-phase motor should be brought to synchronism and its speed maintained by outside power, one phase of the current might be suppessed, and from the windings previously carrying that phase a current may be taken similar in all respects to the suppressed current; the induction motor thus performing the service of a transformer at once capable of changing the voltage and phase of the primary current in any manner desired. Obviously, if this be done, induction motors may easily be run from any single phase system by the means of such a phase-changing transformer, and this new form of transformer will not only do away with the necessary complications of multiphase wiring systems, but will even admit of alternating current distribution in electric railroad service, remedying such evils as attend direct current railroad working. At the present time we lack the mechanical details of this transformer, but it will at once be seen that the motive power necessary for driving the armature after it has been brought to synchronism is not greater than is necessary in the ordinary form of rotary transformer, while the importance of any system of power transmission from a pair of single phase lines has been well attested by the introduction of the monocyclic system, which assuredly is not more efficient, though more complicated, than the transformer system of Ferraris and Arnot.

Literature.

ANY BOOK PUBLISHED MAILED UPON RECEIPT OF PRICE BY THE JOURNAL OF ELECTRICITY.

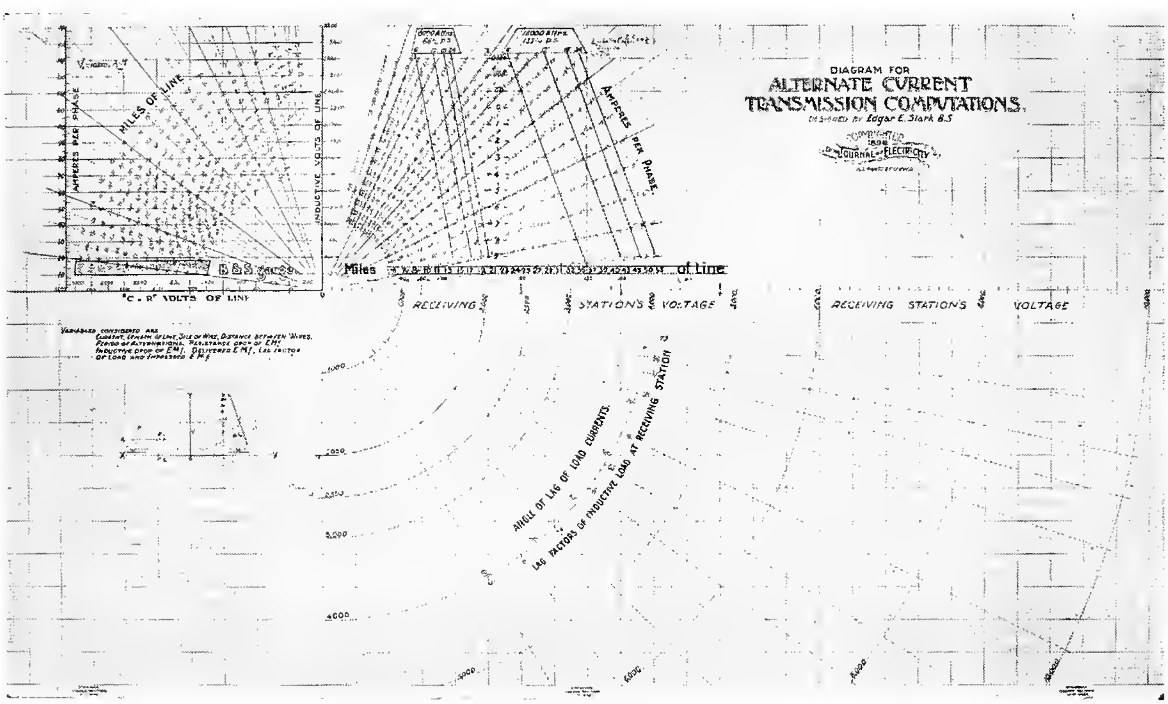
ALTERNATE CURRENT TRANSMISSION COMPUTIONS. By Edgar E. Stark, B. S. A complete wiring hand book with diagram. In preparation, by the Journal of Electricity, price $1.50.

Of all the literature that has been brought out concerning various modes by which the distribution of electric energy is effected, there is as yet none which fulfills with any approach to satisfaction the exacting requirements of the engineer who, fully cognizant of the importance of the various factors of alternate current transmission, desires at his command a ready and con-

venient means of avoiding the intricate and fatiguing calculations by which the data essential to the construction of transmission lines must at present be derived. Himself an engineer and being of wide experience in the design, construction and installation of transmission plants, none have appreciated more fully than Mr. Stark the amount of time that is lost by reason of these intricate calculations and a full appreciation of the convenience of some means whereby the engineer at a glance could determine the size of wire required to fulfill any given service, led him something more than two years ago to a series of investigations upon which the diagram herewith briefly outlined is based. Since that time the author has been almost constantly at work upon the subject and the results of his labors are shown in the work soon to be presented.

A synopsis of the work is best given in the statement that it embodies both in an elementary and a theoretical way a full consideration of each and every factor entering into the problem of transmission by alternating or polyphase currents, and in presenting this subject the author has thoroughly grasped the idea that no branch of electrical engineering offers a wider scope for original research, or is so little understood, or embodies features concerning which the electrical public at large desires more clear and lucid explanation than that of the calculations of alternating circuits. It is evident from Mr. Stark's work that his endeavor is that every reader of his book shall have a clear understanding of the points involved, whether the reader be a lineman, a station attendant or an engineer, or in brief, whether he be of rudimental or of the highest education. It follows therefore, that there are portions of the work which in the mind of the theoretical student might have been omitted to advantage, and conversely, it will also seem to many that little has been gained by bringing out in full the theoretical deductions upon which the diagram has been constructed. To have omitted any portion, however, would have seriously detracted from the value of the book as a complete exposition of all that pertains to the practical consideration of transmission lines carrying alternating or polyphase currents.

The general outlines of the diagram will be evident in the accompanying illustration. In itself the chart considers the ten chief variables in transmission computation, namely; current, length of line, size of wire, distance between wires, period of alternations, resistance drop of electro-motive force, inductive drop of electro-motive force, delivered electro-motive force, lag factor of load, and the impresed electro-motive force. The range of the diagram is from 0 to 10,000 volts at the receiving station, while from the scale the ohmic and inductive volts considered each range from 0 to 3,200 volts. The length of the transmission line runs from 6 to 55 miles. Its periodicities vary from 33 to 165, while the amperes run as high as 160 per phase. Moreover the lag factors of inductive load at the receiving station vary from 50 per cent. to 99 per cent., which fully includes all translating devices that may be in use. The diagram is so laid out as to enable the derivation of factors for transmissions of any distance or voltage from which may be readily derived the required data for that distance or voltage.



"ALTERNATE CURRENT TRANSMISSION COMPUTATIONS." BY E. E. STARK.

Mr. Stark's work will, in brief, satisfy every requirement and the layman in transmission computations who does not comprehend the meaning of the term "lag factor" for instance need not be dismayed because of its use, owing to the full explanations and accompanying diagrams which have been given.

STEAM, ITS GENERATION AND USE. Babcock & Wilcox Company. Twenty-ninth edition. Printed for free distribution. 182 pp. New York and London. January, 1896.

We have received with pleasure a new edition of the valuable handbook on Steam and Its Generation, published by the Babcock & Wilcox Boiler Company. No extensions have been made in the matter relating to boilers and boiler tests printed in the previous editions, and which is already so familiar to engineers, but the book has been extended by twenty-two pages of cuts,

illustrating new boiler plants throughout the world and the system of steel forgings required in the construction of the boilers for withstanding high pressures of steam. These features being mainly photographs tell their own story and illustrate very clearly this advance in steam boiler construction, as well as the latest designs of steam generating plants, where we notice particularly a tendency to follow the lead of the Edison Company in placing the boilers and coal storage above the level of the engine-room floor. That this should be not only possible, but a growing, tendency, disposes at once of the question of wet steam from such boilers for this construction would not be possible were priming likely to occur. The use of steel in these boilers has required some remarkable shapes in sheet metal forging, and the possibility of such shapes in malleable steel places in the hands of engineers a means of boiler and steam-pipe construction far more reliable than has heretofore been possible with cast-iron parts.

RUHMKORFF INDUCTION COILS. By H. S. Norrie. New York. Spon & Chamberlain. Paper. 180 pp. Price 50 cents.

The interest that has been awakened by the Roentgen experiments in high potential induction phenomena have called forth this little handbook on the practical "construction, operation and application" of Ruhmkorff induction coils to which has been added some chapters on the manufacture of the Tesla coil with the Thomson air gap source of alternating electromotive force.

While belonging to a class of timely books (having been composed of chapters collected from the author's writings in periodical literature), the book does not show evidences of hasty construction or of unscientific methods, but is mainly striking for the fact that in it are embodied the most correct principles in the design of induction apparatus; indeed, we do not remember having seen a handbook of induction coil construction in which a writer avoids so thoroughly "rule of thumb" methods as is shown in this work. The coils described are not simply those for the production of a slight physical shock, but also the methods of manufacturing very high potential coils are here very clearly laid out, together with the most recent methods of constructing contact breakers and condensers.

The application of the coil to Geissler tube phenomena has been carried beyond the stage of "play" science into spectrum analysis and Roentgen tube manipulation. Here for the first time a practical Tesla induction coil is described, and the proportions determined from experience, explained so completely that they may be followed by any one capable of attempting this class of experimentation. That the author should be able to lay down in a few pages such clear and satisfactory rules for the construction of this apparatus leads to a feeling of disappointment that he has not undertaken a more careful study of the theory underlying the action of the apparatus itself, for while such an amount of theoretical discussions as would be necessary might unduly increase the bulk and cost of this manual, it is nevertheless true that even amateur experimentalists are more and more breaking away from the idea of "play" science, and endeavoring to understand more clearly the principles of the action of scientific instruments whose phenomena they are enjoying.

In the chapter on condensers we notice no hint of the manufacture of condensers with built up or composite mica sheets, nor those made with varnish insulation, which have recently been brought to so high a state of perfection, and similarly throughout the book the criticism might be made of too many subjects treated less than completely. Elementary instructions on primary and secondary batteries are out of place in such a work at the present time, while more extensive descriptions of spectrum analysis and gas decomposition might profitably have been added.

As an elementary handbook the book is to be commended on the principle that the instruction contained is very explicit and in no sense misleading.

WILLIAM GILBERT, OF COLCHESTER, on the Loadstone and Magnetic Bodies. Translated by P. Fleury Mottelay. New York, John Wiley & Sons, 1893. 358 pp. Price $4.

Inductive science surely owes as much to William Gilbert, of Colchester, as to his contemporary, Lord Bacon, for Gilbert employed the method without the theory, while Bacon explained the theory of the method without its application. Accordingly Gilbert's treatise has been looked upon by electricians as the foundation work in their science, and the methods employed by this physician of Queen Elizabeth's court cannot be too carefully studied by those of us at the present time who are prone to prefer theorizing upon the discoveries of others rather than attempting such discoveries on their own account.

A study of this book will show not only that Gilbert was capable of making careful experiments and of seeing the truths of nature as taught by his experiments, but it will show how far an experimental mind might wander afield in metaphysical speculations on leaving the experimental laboratory.

Before Gilbert's time the compass was used, and its properties mainly understood, though the principle of the loadstone and of the magnet where too completely confused in the metaphysical speculations of schoolmen, who had observed their more manifest phenomena for their true interconnection and their relation to the earth's magnetic field, to be clearly understood. From a mass of theories and speculations Gilbert rescued the science by carefully testing the properties of definite magnets and of magnetic or non-magnetic materials; indeed, the distinction between these substances was first clearly understood by Gilbert, and no one before his time had offered any proof of the manner of production or destruction of magnets.

The old idea that the compass would be falsified by the application of garlic, that it had an attraction for the diamond, that it might be made to point East and West, were forever laid aside by Gilbert's experiments. He first drew the "field of force" about a magnet and inaugurated the system of plotting such a field by the aid of a small steel magnetic needle which we use today. The earth as a great magnet was scientifically deduced by Gilbert from his experiments upon little magnetic globes about which he had traced the magnetic field and proved the existence of magnetic meridians. That an iron bar could be magnetized in the earth's field without contact with magnetic bodies was Gilbert's discovery.

When we consider the importance of such a firm ground work laid for scientific experimentation we cannot fail to admit the skill and power of careful observation shown by this old doctor, especially when we realize that his life was spent entirely among those with whom theories and not facts were considered to be vital. Nor, when we consider his surroundings, must we wonder that many pages were added in the construction of theories which led him far from his

laboratory and which to-day are relegated to the "limbo" of the curious past, whose imaginings may have raised pleasant possibilities, but which throw little light for the modern scientist upon his present conclusions.

The translation by M. Mottelay has been a labor of love, for which we must render thanks that we have this master done into good, simple English, and it would be small credit to us to join with those who have found fault with his enterprise on account of the fact that it was completed before the society of Gilbert's compatriots had fairly completed their plans for a similar work.

EFFICIENCIES OF AN AIR TRANSMISSION PLANT.

(Continued from Page 127.)

uneven ground by building fires around it and heating it until its own weight shaped it to the surface. It was tested under a hydrostatic pressure of 120 pounds. No leakage was discovered and none has appeared since. As yet only half of the full load of air has been passed through the pipe so no data of value regarding loss in transmission have been obtained. With the present load a difference in pressure between the power house and the mine is not sufficient to be detected. At the mine there is an ordinary air receiver and three 50 h. p. boilers set ready for steam, which are used for receivers.

From the receivers the air is taken into heaters also designed by Mr. Rix, and at present it requires a little over half a cord of good pine wood each 24 hours to heat about 700 cubic feet of free air per minute to 350 to 400 degrees Fahr. The heated air passes through covered pipes to the first cylinder of the hoisting engine from which it is exhausted back into the upper heater where its temperature is again brought to 350 degrees, whence it passes into the second cylinder at 30 pounds pressure. From this it is exhausted through a flue to the change house where it is used for heating and drying clothes. For the first heater also the air for the pump is conveyed some 300 feet down in the shaft in a covered pipe. The pump receives air at about 275 degrees and exhausts it into the shaft at about 60 degrees, giving plenty of cool pure air to the men without fans or ventilators. At present the pump is throwing 600 gallons per minute 240 feet high. In addition, there is a direct acting donkey pump throwing 350 gallons 110 feet high in another shaft 750 feet distant, to which the air is carried cold in a 2-inch pipe over the surface. An old hot water heater is used as a reheater consuming 12 sticks of pine cord wood per 24 hours. The hoisting engine, also designed by Mr. Rix, is a compound direct acting Corliss of 100 h. p. with cylinders jacketed for hot air and calculated to work 3,000 feet down an incline of 35 degrees; while specially adapted to the use of heated air, it takes steam equally well.

Efficiencies often seem to depend largely on the personal equation of the reporter. Mr. Rix spent a number of weeks in making his summary of tests and while agreeing with him in the main the following are submitted as the author's conclusions. In any case the fact is that there is 304 theoretical horse power in the water used at the power house, the work actually accomplished at the mine amounts to 203 horse power, and the cost of reheating is $3 per day.

Efficiency of compression and transmission from water wheel to motors, and not including cost of reheating........................ 79.5%
Efficiency of compression and transmission from theoretical power of the water to the motors, and not including cost of reheating....... 74 %
Efficiency from the water wheel to and through the motors, not including reheating... 71.6%
Efficiency from the theoretical power of the water, to and through the motors, and not including the cost of reheating.................... 66 %
Efficiency of compression and transmission from water wheel to motors, including the cost of reheating expressed in water power. 73 %
Efficiency of compression and transmission from the theoretical power of the water to the motors, including the cost of reheating expressed in water-power.. 68.4%
Efficiency of compression and transmission from the water wheel to and through motors, including cost of reheating expressed in water-power.. 65.5%
Efficiency of compression and transmission from the theoretical power of water to and through the motors, including cost of reheating expressed in water-power... 61.6%

Horse-power of air at works after reheating: 225.32.
Horse-power delivered to compressors by water wheel: 283.
Theoretical horse-power of water used on the wheel: 304.
Horse-power of work actually done by the motors: 202.7.
The horse-power delivered by the water wheel to the compressor, to which is added the horse-power (24.66) which the cost of the wood used in reheating would buy in water: 307.66 = 283 x 24.66.
The theoretical horse-power of the water used on the wheel added to the horse-power (24.66) which the cost of the wood used in reheating would buy in water: 329 = 304 x 24.66.

It may be urged that the conditions are particularly favorable to compressed air, as the transmission is short and the power is not needed for tramways or lighting. For lighting it is admitted without question, and possibly for tramways, that electricity is preferable, but for transmission, were it 20 miles instead of 1,000 feet, it is thought by the author that, taking the whole plant, compressor, transmission pipe and motor, as against generator, transmission wires, transformers and electric motors, the air will prove cheaper in first cost, higher in efficiency, less liable to accident, and less expensive to operate and maintain.

Gas

GAS ENGINE POSSIBILITIES.

While the gas engine has been known and used for many years in a small way, and with remarkably good results as far as economy goes, it is only since a short time that its merits have been fully appreciated. It is now, with the introduction of new methods of gas production, by the use of by-product-saving appliances that go far toward paying the original cost of fuel, and thus reducing the cost of the fuel gas to a very low figure, doing much to solve the problem of cheap and effective power.

As these gases are low in illuminating qualities, they are very much better suited to give the highest efficiency in the gas engine. Another gas that has recently been discovered has remarkable qualities under compression, and can be reduced in volume 400 times at 800 pounds, and when expanded will burn with twenty times its volume of air, requiring only 0.4 of a pound of it when compressed to develop one-horse power per hour. Each cubic foot of it at this pressure weighs thirty pounds, and, therefore, contains seventy-five horse-power hours, being the greatest storage of energy ever known for a given weight.

This opens a wonderful field for the development of power for motors for tram cars and other classes of motor vehicles, as well as pleasure boats. Gas engines, working with this new fuel gas, are likely to have a very large use in all stationary work, and for propelling boats, and it may not be beyond the bounds of possibility to drive ocean steamers and locomotives of the future by gas engines. It is especially suited to the generation of electricity, particularly when the electric plant is located at inaccessible points where it cannot be

reached by boat or rail, and where coal would have to be carted and from which ashes would have to be removed.—George S. Strong, in Cassier's Magazine.

PACIFIC COAST GAS ASSOCIATION.

The fourth annual meeting of the Pacific Coast Gas Association held in San Francisco on July 21st to 23rd, inclusive, proved to be one of the most interesting and instructive conventions of that organization. The following members of the Association were present:

H. E. Adams of Stockton, Charles Adams of Portland, C. R. Allen of San Francisco, C. E. Burrows of Walla Walla, Washington; J. A. Britton of Oakland, A. Corrigan of San Francisco, D. J. Collins of Philadelphia, J. B. Crockett of San Francisco, C. M. Converse, of San Francisco, John Clements of Red Bluff, Frank A. Cressy of Modesto, S. B. Cushing of San Rafael, James McNeil of Santa Cruz, M. C. Osborne of Santa Cruz, T. R. Parker of Napa, Thomas D. Petck of Eureka, R. M. Powers of San Diego, B. U. Steinman of Sacramento, E. F. Sherman of Portland, L. P. St. Clair of Bakersfield, G. H. Taylor of Chico, George Thompson of Woodland, A. J. Vanderwhite of San Francisco, J. P. Grimwood of San Francisco, John L. Howard of San Francisco, E. C. Jones of San Francisco, J. C. Kaneen of San Rafael, D. E. night of Marysville, B. A. Knight of San Francisco, George Keaton of Gilroy, H. T. Lally of San Francisco, H. J. Lewelling of St. Helena, C. O. G. Miller of San Francisco, P. Meyer of Livermore, W. B. Cline of Los Angeles, W. M. Duval, W. Dunbar, F. H. Eichbaum, Richard Fenner, C. F. Fogg, C. Troelich of San Francisco, H. P. Goodman of Napa, R. P. Greer, O. M. Gregory, W. W. Gillespie of San Jose, W. S. Wharton of Fairhaven, Washington, G. W. Wilson of Vallejo.

The following officers were elected to serve during the ensuing year:

T. R. Parker of Napa, President; F. H. Eichbaum of San Francisco, Vice-President; John A. Britton of Oakladn, Secretary and Treasurer; L. P. St. Clair of Bakersfield. M. C. Osborne of Santa Cruz, J. Clement of Red Bluff and R. M. Powers of San Diego, Directors.

President E. C. Jones delivered an address of welcome, during which he said: "The future of the gas business looks bright in the promise of prosperity; we are not wedded to any kind of gas, or any method of producing it. and by our untiring efforts to extend our business by introducing new gas consuming devices and cheapening the cost of prduction, by the adoption of the latest improvements we shall mold the future of the gas business. The future of our business lies in the hands of the gas engineer; he is its custodian, and on his studious thought and earnest work depends the measure of its brightness."

As will be seen from the following list of papers presented the topics discussed presented a wide range of subjects, but owing to a resolution of the Association to the effect that the papers presented or the discussions brought out may only be published through the official organ—The American Gas Light Journal of New York—out of respect to the Association it is impossible to publish any portion of its transactions. The papers discussed were as follows:

(1.) "The Economical Uses of Coal," John L. Howard, San Francisco; (2) "The Relative Position of Consolidated Gas and Electric Light Plants," M. C. Osborn, Santa Cruz; (3) "Oil Tar and Its Uses," J. B. Grimwood, San Francisco; (4) "Telescoping a Single Lift Gas Holder While in Use," J. L. Fogg, San Francisco; (5) "Gas Stoves," D. Decker, Fresno; (6) "Evolution of the Gas Meter," Chas. H. Dickey, Baltimore, Md.; (7) Municipal Ownership," John A. Britton, Oakland; (8) "Water Gas," Chas. F. Adams, Portland, Or.; (9) "Wrinkles," T. R. Parker, Napa; (10) "Experiences," John Clements, Red Bluff.

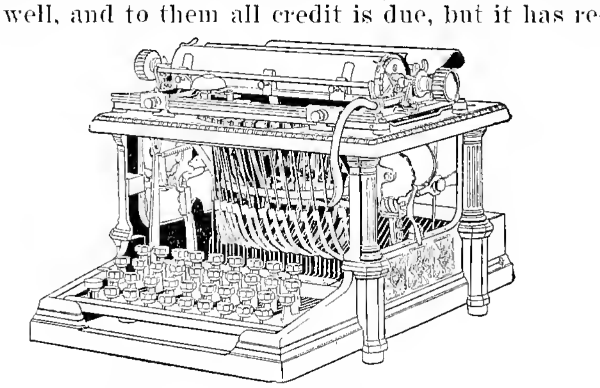
During the proceedings exhibitions were made of acetylene gas and the mode of shadowgraphing by means of Roentgen rays. The last day of the meeting was devoted to a delightful excursion and luncheon on Mt. Tamalpais as the guests of Mr. S. B. Cushing, President of the Mt. Tamalpais Scenic Railway Co.

The Trade.

A NEW TYPEWRITER.

The Howe Scale Company, with office and salesroom at Nos. 12 and 14 Pine street, San Francisco, Calif., are the Pacific Coast representatives of the Remington-Sholes Typewriter, a new machine in this field, but its manifest advantages over the older makes of writing machines will at once place it in the front rank here as elsewhere.

Twenty or more years ago, a combination of the elder Sholes and the Remingtons brought out what is now known as the Remington Standard Typewriter, which has in name and in fact been the Standard writing machine of the world. The first generation did its work well, and to them all credit is due, but it has remained for the sons of these pioneers in the typewriter field to bring out a writing machine in which are incorporated the most valuable features of the various makes of typewriters now on the market, together with many new improvements, which make the Remington-Sholes the typewriter par excellence.



THE REMINGTON-SHOLES TYPEWRITER

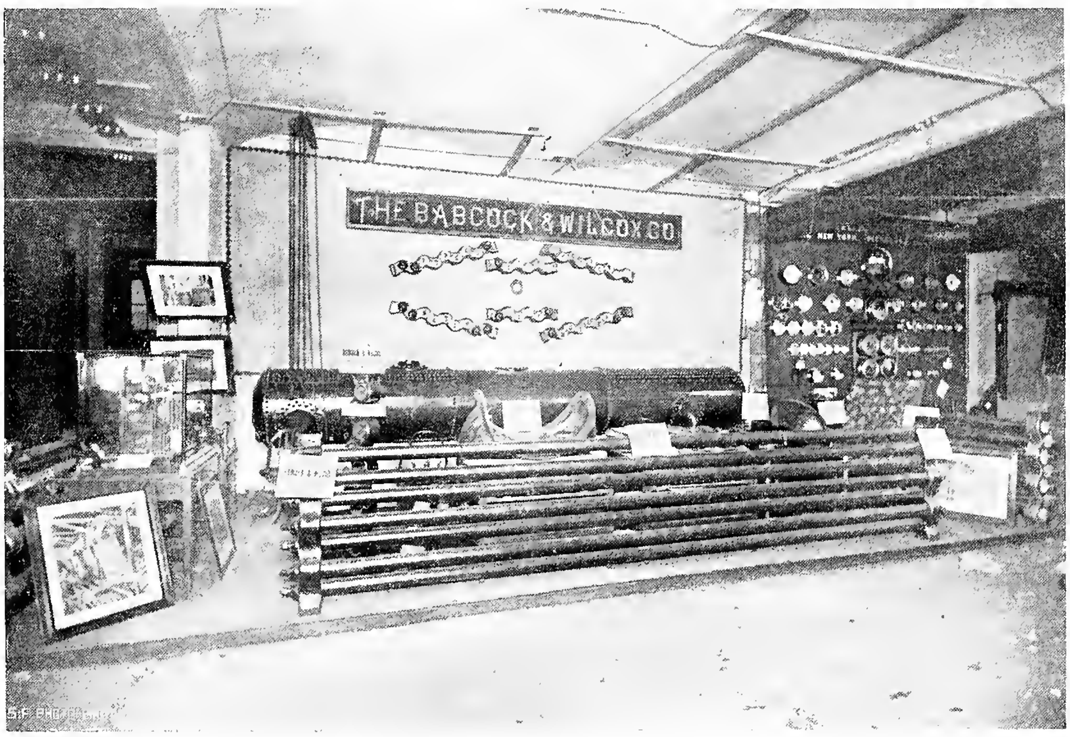
Among the many new and original ideas that have been embodied in this modern machine, may be mentioned the absolutely rigid carriage, in connection with the Universal Keyboard, such as is used on all Standard shift-key machines. It is the only machine on the market in which the ordinary nine-inch carriage can be instantly changed for the twelve-inch carriage, thereby serving the purpose of two machines. These carriages are made very strong and extremely simple, having some forty less parts than any standard machine, and to see the work, simply the cylinder alone is turned up high enough to allow of easy erasure.

This machine has been constructed with the view of enabling the operator to do his own repairing. All parts are made interchangeable and can be removed im-

mediately by any operator of ordinary intelligence.

In point of finish it is by far the handsomest machine of any we have yet seen, being finished in what is known as the Bower-Barff process, and presents an appearance unsurpassed for quiet elegance and artistic effect.

The fact that Mr. Allan Mc. D. Riddell, formerly manager of the Pacific Coast Agency of Wyckoff, Seamans & Benedict, manufacturers of the well-known Standard Typewriter, and Mr. J. V. Sweetser, late sales agent of the same concern, have resigned their position to accept a similar situation in behalf of the Remington-Sholes Typewriter, are straws demonstrating that the Remington-Sholes Typewriter machine is superior to every other hertofore offered. It may be added that the new Typewriter has been adopted by the Journal of Electricity after a thorough examination of practically every other typewriter in use.



RECENT IMPROVEMENTS IN STEAM BOILERS.

The exhibit of the Babcock & Wilcox Company, makers of forged steel sectional high pressure boilers at the National Electrical Exposition recently held in New York, is situated on the ground floor and covers a space of 500 square feet. The space is admirably situated for the display of the parts which go to make up their well known steam boilers. They exhibit the various parts of their sectional water tube boilers, arranged in such a manner that the visitor is afforded every opportunity for the most critical examination of each individual part. The lighting of the exhibit is a feature that has drawn pleasing comment from many of the Electrical Convention delegates. To the investigator interested in the economical production of steam under high pressures, this exhibit will repay the time spent in a visit.

A 36-inch steam and water drum is arranged on rolls, which enables the attendant to so revolve the drum as to bring into view every portion of its construction in order that the visitor may more minutely examine the design and workmanship. The cylindrical portion of the drum is made of three sheets of open hearth steel. The longitudinal seams are butt-strapped inside and out. All holes are punched 5-16 inch smaller than the diameter of the rivets to be used, through steel templates, and drilled out the full size after the sheets are rolled and assembled with the butt-straps in position. After drilling, the straps are removed, all burrs cleaned off and the plates re-assembled, metal to metal, with parallel turned bolts fitting the holes before riveting. Each course is then built independently to template. The various courses and their heads are assembled by an hydraulic forging press at a pressure of 12 tons. All rivets are driven with a 60-ton pressure and held until cold. The drumheads are fitted with manholes. These heads are forged at a single heat with the extra manhole rings and stiffening plate in position, and have flat raised seats for stand pipe and feed connections. The edges of the head and manhole faces are machined off true. The manhole fittings are of forged steel. The plate is machined and turned to a true oval to fit the head. The steam flanges are of forged steel, recessed to make a male and female joint, fitted with stud bolts, tapered threads and inside keeper nuts. This standard steam and water drum is tested in the shops and again when erected on the purchaser's premises to 300 pounds hydrostatic pressure.

The crossboxes into which are expanded the water circulating uptakes are forged from a single sheet of open hearth steel without seams or rivets.

The three sections shown, and used as a fence around the exhibit, are built up of 4-inch tubes, expanded into forged steel headers. These tubes are made of the best knobbled and hammered charcoal iron blooms of standard weight and of such quality that a 1500-pound hammer dropped five feet onto a tube shall crush the tube without showing cracks or flaws. These sections are subjected to an hydrostatic pressure of 400 pounds after assembling.

The header shown standing upon end is forged from a single sheet of openhearth steel, serpentine in form, disposing the tubes in a staggered position when assem-

bled in the furnace. The method of expanding the tubes is shown, as also the cap, clamps and handhole fittings.

The handholes are of sufficient size to permit the cleaning, removal and renewal of a tube, the handholes being placed opposite the tube ends. The handholes have a raised seat milled off to a true surface and covered on the outside with a forged steel cap (also milled to a true surface) and held in position by a forged steel safety clamp, closing the handhole opening on the inside and secured by a bullhead bolt to secure correct alignment, and a forged cap nut. This method of closing handholes is a perfect one mechanically, insuring a tight joint, metal to metal, without packing of any kind.

They show a line of high pressure brass steam boiler fittings designed for any pressure demanded. These fittings are the design of the Company and are the product of their many years of designing and constructing high pressure plants. These fittings are now in use on boilers working at 350 pounds pressure.

Photographs of many of the large plants installed by the Company are shown, and also photographs of their Chain-Grate Automatic Stoker.

They show also a model of their standard high-pressure sectional boiler. It is perfect in every detail, and is capable of generating steam. The boilers built by this Company of the forged steel type are the only sectional boilers made of forged metal—all others using cast iron or steel. They are designed throughout to carry safely a working pressure of 200 pounds per square inch.

As is well known, Mr. Stephen Wilcox was the inventor of the inclined tube type of water boilers—the type now almost universally used. The Babcock & Wilcox Company have on exhibit there Mr. Wilcox's original model of his invention made in 1856. This model is historical, though the bent tubes shown were discarded very soon for the straight tubes now used, and the boiler was changed step by step into its present sectional form nearly thirty years ago. Then came the substitution of forgings for castings until the present type was developed. The forgings shown, particularly the serpentine header, are the most difficult and intricate ever attempted and represent the most advanced work yet done in steel forging.

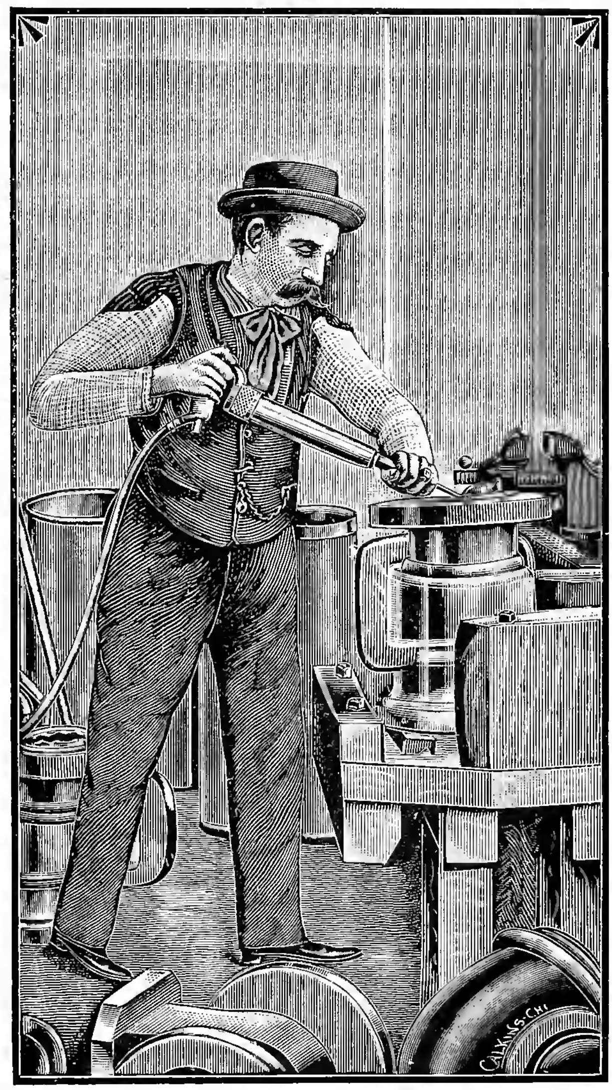
PNEUMATIC SHOP TOOLS.

During the past week there has been an exhibition at the show rooms of the Rix Compressed Air Machinery Company, some of the Pneumatic Tools manufactured by the Chicago Pneumatic Tool Company, which has placed its agency with the above San Francisco firm. Five or six different sizes of these tools were in operation, carving marble, chipping castings, cutting granite, driving rivets and calking boiler seams. The tools seem to be admirably adapted to the work and are quite marvelous in the rapidity and accuracy of their operation. In carving marble the material appears to melt away in front of the tool, without effort, and with the smaller sized tools, running at medium speed, the blow is so light and delicate that it cannot be imitated in any hand tool.

These pneumatic tools are light and easy to handle and are under the perfect control of the person manipulating them. Various tools of any size can be instantly placed in the hammer, and there is no delay in making changes. In doing iron work, such as chipping castings or in calking boilers, they do the work of about three or four men, and do it, of course, much more perfectly.

They are distinctly a labor-saving device, and besides the uses above mentioned, they can be used for driving nails, wood drift pins in ship building, chipping castings, cutting boiler plate, cutting out flues, fire box patches, stay bolts and rivets. In beading locomotive flues the Company guarantees that their tools will bead $2\frac{1}{2}$ flues per minute and much more perfectly than can be done by hand.

For carving the ornamental work on the faces of stone buildings, these tools prove money-makers for the contractors. A small air compressor, driven by a gaso-



line engine, could be placed upon an ordinary truck, and air in a small hose could be carried to the tools, which could be operated upon the face of the building. Contractors find them greatly to their advantage for carving the fronts of Eastern buildings, both in the saving of money and in the saving of time. In California sand stones, which are comparatively soft and easily worked, the tool should prove quite an advantage to stone cutters. New uses are constantly being discovered for this little tool, and there seems scarcely any limit to its usefulness about manufacturing work of any kind.

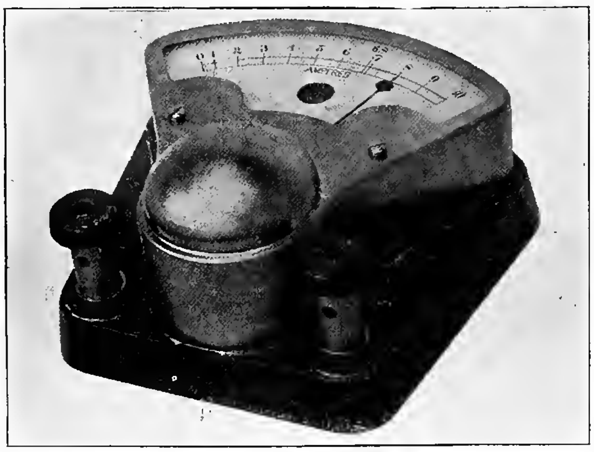
There will be an exhibition given in the Mechanics' Fair this year, by the Rix Compressed Air Machinery Company, of many compressed air devices, among which will be these tools in operation, so that the public may see for themselves how useful and economical they are.

THE WALKER COMPANY IN CALIFORNIA.

The genuineness of the competition of the Walker Company will be appreciated in the announcement that it will in the near future establish a Western factory for the assembling and erection of its Pacific Coast products and for general repair shops. This factory will be consolidated with the new establishment of the Abner Doble Co., which is soon to be erected on the corner of First and Main streets, San Francisco. From the design of the building it is evident that the factory will be by far the most modern of any on the Pacific Coast.

THOMSON ARC CIRCUIT AMMETER.

The standard instruments which the General Electric Company has lately placed upon the market includes the Thomson Arc Circuit Ammeter. This is a high grade instrument for switchboard purposes, and is mounted upon black enamelled metal base, with the cover, binding posts and screws of bright nickel. It



measures over all 8 inches by 8 inches.

The qualities claimed for this instrument, which should recommend it to those connected with the arc lighting plants, are its high degree of accuracy, its perfect and permanent reliability for service, together with an absolute dead-beat movement of the pointer. The scale is long and may be clearly read from a distance. One ammeter may be used for either half or full arc circuit, the divisions being wide and the calibration marked for both services. Permanency of calibration is obtained by the elimination from the instrument of any parts liable to change. Each ammeter is provided with a self-contained and conspicuous Polarity Indicator, consisting of two signals—the white showing under normal conditions, the red on reversal, the latter remaining in sight until the current has once more passed through the instrument in the proper direction. The ammeter may be used for front or back connections, connection posts and studs being furnished as conditions require. Several of these instruments were shown at the Electrical Exposition in New York during the Convention of the Electric Light Association and elicited much favorable comment.

INFORMATION WANTED.

Mr. W. F. Forsey, secretary and manager of the Co-Operative Packers' Association of Fresno, Cal., writes: "Will you kindly put the writer in communication, or obtain for him the necessary information in regard to the cost of a reduction plant for extracting aluminum from aluminum clay, and also the estimated or actual cost per ton of producing aluminum."

"MORE THAN CREDITABLE."

The following self-explanatory letter reflects the sentiment of many readers who find the Journal to be specially active in chronicling the condition and advances in the state of the applications of electricity on the Pacific Coast. It is produced verbatim:

OAKLAND, Cal., June 12th, 1896.

Geo. P. Low, Esq., Editor Journal of Electricity, San Francisco, Cal.

Dear Sir:—I read with more than ordinary interest your publication of the long distance transmission installed for the San Joaquin Electric Company at Fresno, and cannot forbear complimenting you upon the meritorious publication both from an electrical and mechanical standpoint.

Your illustrations are all that could be desired while the letter press is more than usually intelligent.

I hope that on the Pacific Coast you will meet with the reward which your service to the cause of electrical distribution merits. Your paper, in my judgment, ranks as high as any journal of like character in the East, and the particularly adaptable field in long distance transmisson has given you an opportunity for the edification of your readers in presentng a more than creditable article not only on the Fresno plant but also on the Folsom transmission.

Wishing you every success, I am,

Yours very truly,
JOHN A. BRITTON.

The Replogle Governor Works, of Akron, Ohio, by Mr. W. C. Parsons, Secretary, also writes: "We have received a copy of your Fresno Edition published in April, and were much interested in th handsomely illustrated article on the plant of the San Joaquin Electric Company. We have seen dscriptions of this plant in other papers largely copied from your article, but none of them coming anywhere near equal to the elegance of your pubication."

ELECTRO-MAGNETIC "BILKS."

The much-debated question of the physiological effect of magnetism has been authoritatively set at rest. Experiments were conducted at the Edison laboratory to determine the effect produced on persons subjected to a magnetic field of great power. The conclusion reached was that the human organism is in no way appreciably affected by the most powerful magnet known to modern science, either as regards circulation, ciliary or protoplasmic movements, or sensory or motor nerves. It was further shown that the ordinary magnets used in medicine have a purely suggestive effect, and would be equally serviceable if made of wood. This is equivalent to saying that a large proportion of the so-called "magnetic" appliances bought usually without medical advice, for the cure of various ailments, have no healing or curative power whatever, and their influence is purely imaginary.

THE "PASSING" OF MUNICIPAL OWNERSHIP.

Speaking of the fire at Yuma, the Tucson Star says: "There is something passing strange in connection with the destruction of the electric plant."

It is still more passing strange how it can be replaced by another equally good for $350, while the one that burned cost the Territory less than a year ago $3,000. It is passing strange where that $2,650 surplus was placed.—Phoenix (Ariz.) Republican.

WHAT IS ELECTRICITY?

A philosophysing subscriber suggests that Mr. Chauncey M. Depew's famous telegram sent from the National Electrical Exhibition Building to Tokyo and back should have read. "God is, Nature treasures, Science utilizes, Electricity," or in other words, Electricity is the Infinite Power. Nature stores it and Science utilizes it.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

The success of the San Joaquin Electric Company's great venture is now assured and the practical demonstration of the capability of the power developed by the gigantic generators in the distant hills is hailed with delight by the people of Fresno who now have at their command motive power of unequaled strength and cheapness.—Fresno (Cal.) Expositor.

The more trolley lines Santa Ana can secure the better. If one to Orange is followed by another to Anaheim it will be a good thing, and Santa Ana will feel the benefit. The trolley roads, and frequent train service between this town and Pasadena, has helped both Los Angeles and its neighbor, and Santa Monica is showing the benefit the new road has been to it, already. The excellent local service given by the Southern Pacific, Southern California and Terminal roads has helped Los Angeles, as well as the surrounding towns, and Santa Ana will find her experience similar to that of Los Angeles if she follows the example of her big sister.—Los Angeles Express.

Judge D. R. Prince, United States Commissioner at Fresno, is enthusiastic over the outlook for better times at Fresno. "Improvement is in the air," he said yesterday. "Our crops are not as large as they have been in years past, but prices will be better. We are somewhat given to grinning when our friends of Sacramento go into hysteries over their Folsom electric power. It is an insignificant affair compared with our plant at the headwaters of the San Joaquin. After the Niagara Falls plant ours is the finest in the United States, and that means the world. It has a capacity of 80,000 horse power, of which only a fraction is now utilized. The J street and Blackstone avenue line of street cars, principally owned by Charles L. Walter, will be converted into an electric line at once, and will then be extended into the thickly populated section north and east of the city for a distance of from twelve to fifteen miles. Electric light and power is served all over the town. —San Francisco Examiner.

Many important factors are at work in this city and county to make the outlook for the future more than hopeful. Conversations with many business men convince us that there is to be a remarkable growth and development in the near future that will add greatly to the importance of Santa Rosa. There is a reason to believe that more manufacturing industries are to be started soon; that railroad and immigration projects are to add to the city's commercial importance and that there is to be a general expansion of those industries that add to the wealth and prosperity of communities. The development of electrical energy by means of water power will do much to forward the city's growth. It is believed that very soon certain water falls located within seven miles of Santa Rosa will be utilized for the development of electric power. The existence of a high fall in this neighborhood is known to a few, and in the opinion of an expert is sufficient to warrant the projection of an electrical transmission scheme that will do much to foster and encourage manufacturing projects to our town. —Santa Rosa (Cal.) Democrat.

Los Angeles has had a little experience lately that shows the necessity of greater safeguards around bids for franchises. A man who really wanted to build a railroad—ex-Mayor Workman—got the council to advertise the franchise for sale. Nobody else was in sight; nobody else wanted to build it, so far as the public knew, and nobody else was expected to bid on it. But to the surprise of all a dark horse turned up and overbid Mr. Workman, thereby becoming technically entitled to the franchise. The successful bidders did not want to build a road, and had evidently bid only to keep anyone else from building, or to speculate on the franchise by selling it. So, after a perplexed deliberation, the council have concluded that it was not a fair thing and have declared all bids off. The moral is that nobody should be allowed to bid on a franchise unless he give adequate security to do the work in case the privilege is awarded him. The matter of the few hundred dollars bid is a trifle, and is no guaranty of good faith. The security should be away up in the thousands, which nobody could afford to trifle with. Then we should have no more straw bidders.—Pasadena (Cal.) Star.

On the Arizona canal there is a fall of water sixteen feet and if utilized would furnish 1,000 horse power. There are no dams to build, no tail race to cut, a cheap shed or house for shade, and put in place turbine water wheels, attach dynamos, generate a thousand horse power of electricity, sink wells along the Grand, Maricopa and Phoenix canals where water may be had in from 12 to 20 feet, use the Centrifugal pump, and pump the water into the canals, the water will again sink to be pumped up again. There will be a little loss in operation is all. A pump that will require 20 horse power to drive should throw 500 inches of water from a well 20 feet deep. The cost of machinery, enough to fill the three ditches ought not to be $20,000. One man can run the power and one the pump, so here is the expense—two men and say 50 cents a day for oil. The water wheels and pumps will be built of steel, simple and durable. Why this plan has not been carried out is a mystery. Will some of the kickers tell us through the Herald why this plan will not work and is not best?—Phoenix (Ariz.) Herald.

"Gas for lighting purposes is more than holding its own against electricity now," said D. J. Collins of Philadelphia, at the Grand last night. Mr. Collins is the representative of the United Gas Improvement Company, which has plants in thirty-eight American cities. It is one of the largest syndicates in the world. Until about two years ago electricity was making big inroads into the business of the gas companies. It was giving a better light for a comparatively fair price, judged by what had to be paid for a less brilliant illumination by gas. Things have switched around considerably in eighteen months. I do not think that more than 30 per cent of the electric light companies in the country are now paying dividends. Improved gas burners have greatly increased the illuminating power of gas and cheapened the cost to the consumer. Three feet of gas an hour will now do what eight or nine feet did not do so well formerly. Furthermore, these three feet of gas are made to give a 60-candle power light. Ordinary electric lights are 16-candle power and the price per hour is far in excess of the cost of three feet of gas. Gas companies as investments are, therefore, safe against dangerous encroachments from electricity even if the decreased consumption of gas may show some falling off in receipts."—San Francisco Examiner.

The subject of "rapid transit" is engaging, but it fatigues. Like the poor, it is "always with us," and always will be. The hopeful gentleman who believes it a problem capable of solution, and, looking down the dim vistas of the time to be, sees an adequate number of uncrowded cars pleasantly traversing the town on the surface of the earth, in the air above the earth and through the tunnels under the earth, may justly boast a gift of prophecy that is independent of fact and superior to reason. There can never be sufficient "accommodation" for all who wish to travel, for with every increase in the accommodation there is a more than corresponding increase in the number of those wishing to travel: the supply begets the demands, which outruns it. Nothing is more certain than that the discomforts of overcrowding keep out of the cars enough persons to overcrowd them at every lessening of the discomforts by an increase in the number of cars and frequency of trips. To the many thousands of persons who go every Sunday

of the summer to suburban resorts better facilities for reaching these places would add other thousands, until our latter state would be no better than our former. A limited number of persons travel for business; an indefinite but greatly larger number travel for pleasure; and behind these are a virtually inexhaustible multitude who would travel for fun if it were fun to travel. With the accommodations and facilities for which we seraphim and cherubim continually do cry, and at "popular" rates (the rate most truly popular is the least rate), nobody would walk a block—the entire population would rise as one man and board the cars. These be truths to the perpending whereof we might profitably set such ailing understandings as the gods have gifted us withal.—Ambrose Bierce in San Francisco Examiner.

Not long ago one of the principal mining companies in the Bodie district, was casting about to see how they could make the mines pay dividends. Fuel for steam purposes had become so expensive that a mine of low grade ore could no longer be made to pay. It was suggested that steam should be abandoned for electricity. But there was no water power within eight or ten miles of the mine. One of the small streams was finally taken up, which had a head of several hundred feet. An electrical plant was put in which drives all the works at the mine. The difference is that a non-paying mine has become once more a dividend paying concern. This is not a single instance of the transition from one system to another. But it will serve very well as an illustration. A new era of mining in California has just begun. Wherever electricity can be used as power, it will be employed. It settles the question of fuel at once. A mountain stream ten or fifteen miles distant, is not too remote, provided a sufficient head of water can be obtained. The power created can be converted into electricity and transmitted to the mine with the best results.

The great mother lode in Calaveras and Amador counties, which has turned out so many millions, has been worked thus far by the use of steam. This lode is believed to extend hundreds of miles. The news comes that Engineer Hammond, of South African fame, is now on his way to California as the representative of foreign capitalists, who bought and bonded a large number of claims on this mother lode, and are about to work them by the employment of electricity generated by water power. Men who have exploited the South African mines find themselves drawn to the mines of California. They will employ the processes which have made mining a successful industry elsewhere. A mining company starting with two millions and having another million in reserve, with a famous American mining engineer to lead off, is probably the beginning of the new mining development in California.—Oakland (Cal.) Tribune.

Personal

R. S. Masson has been promoted to the District Engineership of the Pacific Coast office of the Westinghouse Electric and Manufacturing Company, with headquarters at the Mills Building, San Francisco.

Professor A. Van der Naillen has returned to San Francisco after a three months' tour of the principal scientific centers of Europe where he has been engaged in purchasing apparatus and gathering ideas for the betterment of the Van der Naillen School of Engineering.

Mr. Charles S. Knight, manager of the Fort Wayne Electric Corporation, and who was a recent visitor to San Francisco, has returned to Fort Wayne, via Portland, Or. He will probably be on the coast again by the latter part of August.

Mr. Edgar E. Clark, of the Engineering Staff of the Stanley Electric Manufacturing Company, and who has been on the Coast for the past year mainly for the purpose of supervising the transmission plant of the Nevada County Electric Power Company, will shortly leave for Bonita, Mont., to erect for the Golden Scepter Mining Company a 360 k.w. Stanley generator and transmission plant.

At the recent commencement exercises of the graduating classes of '96 from the Stevens Institute of Technology, Hoboken, N. J., the degree of Doctor of Engineering was conferred upon Commodore George W. Melville, Engineer-in-Chief of the United States Navy, in appreciation of the excellent engineering work performed by Commodore Melville for his country and the advancement of the science of steam engineering, well illustrated in the world-wide famed "White Squadron." Only once before, in the twenty-five years' history of the Stevens Institute has the degree of Doctor of Engineering been conferred, and then upon Professor R. H. Thurston, of Rhode Island, who formerly occupied the Chair of Mechanical Engineering in Stevens Institute, and is now director of Sibley College, Cornell University.

Mr. John M. Klein has resumed the sole ownership of John M. Klein's Electrical Works, Mr. Marion L. Mowry having resigned from the partnership heretofore existing.

Mr. J. R. McKee, manager, and Mr. F. O. Blackwell, chief engineer of the Power and Mining Department of the General Electric Company, of New York, have returned to Schenectady after a hurried inspection of the General Electric transmission plants at Fresno, Sacramento and Portland.

Mr. J. P. Williams, of the Chloride Battery Company, was in San Francisco recently. Among other matters Mr. Williams is understood to have given considerable attention to the matter of a Pacific Coast agency for the Chloride Company, and it is probable that the agency will be placed with Mr. Irving M. Scott, of the Union Iron Works.

Mr. C. P. Gilbert, at present Managing Director of the Edison Illuminating Company, of Detroit, has submitted his resignation, to take effect August 1st, after which date he will assume the managing directorship of the Sacramento Electric, Gas and Railway Company, which recently succeeded to the property and interests of the Folsom Water Power Company, the Sacramento Electric, Power and Light Company, and the Central Electric Railway Company, of Sacramento.

Obituary

Mr. John M. Gamewell, inventor of the original box of the fire alarm system which bears his name died of heart disease in Hackensack, N. J., on July 19th. Mr. Gamewell was born in Marleborough, N. C., and attained the age of 74 years.

Reports of the Month.

INCORPORATION

Los Angeles, Cal.—The Tejunga Water and Power Company. Object: To own and operate water, power and electric works. Capital stock, $5,000,000. Directors, J. W. Craig, L. R. Garrett, S. Merrill, R. W. C. Wilson and M. L. Wicks.

San Francisco, Cal.—The L. Kollman Company. Capital stock, $100,000, of which $60,000 has been subscribed. Objects: To manufacture mechanical and electrical devices. Directors, A. Iverson, M. Greenblatt, Robert Capelli, Joseph C. Meyerstein, Joseph E. Bien and Peter De Tamble.

Fresno, Cal.—The Stockton and San Francisco Electric Power Company. Objects: To develop power in the Sierra Nevadas and transmit it to San Francisco. Capital stock, $5,000,000, of which $2,475,000 has been subscribed by L. E. Walker, Sig. Wormser, F. Younger, Charles G. Bonner and J. C. Shepard.

Marysville, Cal.—At the meeting of the stockholders of the Marysville and Nevada Power and Water Company, held in Smartsville, they organized by the election of the following officers: President, John Spaulding, of Placer county, General Manager of the South Yuba Canal Company; First Vice-President,

D. P. Donohoe, Marysville; Second Vice-President, R. C. Walrath, Nevada City; Secretary, Louis Conrath, Smartsville; Treasurer, J. K. O'Brien, Marysville; Attorneys, W. H. Carlin, Marysville, and G. L. Hughes of Nevada City; Directors, John Spanding, R. C. Walrath, G. L. Hughes, W. F. Engelbright, D. P. Donahoe, J. K. O'Brien and Louis Conrath. W. L. Waggoner will be engineer, and W. F. Engelbright consulting engineer. The company has acquired the water rights of the Yuba river at the Narrows. Capital stock, $2,000,000, of which $1,040,000 is subscribed.

Great Falls, Mont.—The Great Falls Electric Light Company. Capital stock $30,000, all subscribed and assessable. The first board of directors are John F. Cowan, Charles N. Atkinson and Robert Vaughn.

COMMUNICATION.

Arcata, Cal.—A telegraph line will probably be constructed from the terminus of the Vance railroad in Humboldt county to Trinidad.

Visalia, Cal.—On August 12th the Common Council will sell a franchise for a telephone and telegraph system in and upon the streets and alleys of the city of Visalia.

LITIGATION.

Sacramento, Cal.—A jury in the case of Claire vs. Sacramento Electric, Power and Light Company has rendered a verdict of $2,000 and costs for damages alleged to have been received by the plaintiff from an electric railway guy wire. The verdict of the jury was based on the belief that the plaintiff was rendered partially deaf by reason of his ear touching the guy wire.

Portland, Or.—Judge Shattuck, of the Superior Court, has rendered Mrs. Christina Olsen findings for $1,050 in her suit for $2,500 damages against the Portland General Electric Company for injuries received from contact with a guy wire.

Oakland, Cal.—J. W. Siemson has sued the Oakand, San Leandro and Haywards Electric Railway for $5,000 damages for injuries alleged to have been received from the overturning of a car.

San Francisco, Cal.—The Supreme Court has affirmed the decision of the Lower Court in the suit of James A. Weymire et al. vs. the San Francisco and San Mateo Railway Company et al. The San Mateo road issued to the Trust Company, in May, 1891, 1,100 bonds at $1,000 each, giving a trust deed to its plant and franchises. Three years later the Trust Company sued the mortgagors in compliance with the terms of the trust to foreclose it and have a receiver appointed. Pending this action Weymire and other stockholders in the railway sued to enjoin the Trust Company from prosecuting its action on the ground that the bonds had been fraudulently issued without consideration, and all transfers of these bonds to the defendants were asked to be declared void. The lower court ruled against Weymire, and from this ruling an appeal was taken to the Supreme Court, resulting as stated.

Alameda, Cal.—The case of Fleming vs. the City of Alameda has been practically settled by Judge Frick, of the Superior Court, who has verbally dissolved the preliminary injunction granted Fleming, and will file a written opinion later. The Court expressed the opinion that the City Trustees were justified in incurring expenditures for power at the City Electric Light Works.

Los Angeles, Cal.—The warfare being waged between the Los Angeles Lighting Company and the Gas Consumers' Protective Association has reached the courts in a suit brought by the latter against the former for $25,000 damages, alleged to have been sustained by removal of certain gas governors from the Los Angeles county court-house, and other buildings situate within the city of Los Angeles. The complaint recites that on or about June 15, 1896, the defendant unlawfully entered upon the premises of the above parties and removed from and disconnected with said premises all of the gas-saving apparatus of the plaintiff company. An injunction is asked restraining the Los Angeles Lighting Company from interfering with any of complainants' gas appliances and for damages as stated. Mrs. R. M. Dale, a lodging-house keeper, has also brought suit for $2,000 against the Lighting Company for damages alleged to have been suffered by reason of the defendants removing a gas governor and refusing to allow its replacement. The Lighting Company does not object to the use of gas regulators, and only seeks to compel the Consumers' Association to place its apparatus on the gas pipes in a workmanlike manner without physical injury to its pipes and meters. It appears evident that no trouble would have occurred over regulators had not the Lighting Company's property been seriously damaged by bungling workmen.

Tacoma, Wash.—The city of Tacoma has petitioned the Court against the Tacoma Light and Water Company and the Tacoma Gas and Electric Light Company to set aside and declare fraudulent and void the deed of transfer of the gas plant and all the real estate and other property of the Tacoma Land Company, which was sold or supposed to have been sold to the Tacoma Gas and Electric Company. The complaint was prepared by Attorney Wickersham, as special counsel for the city under the recent ordinance passed by the council, and not only asks to have the transfer set aside, but asks that the gas plant, all of blocks 2200 and 2201, the Puyallup water works and all the shares owned by the Tacoma Light and Water Company in the Commercial Electric Light Company and other valuable properties, be placed in the hands of a receiver and applied to the payment of the city's judgment for $787,500.

In the matter of the City of Tacoma vs. the Commercial Electric Light and Power Company, Judge Stallcup has ordered the temporary injunction continued in force until the case is finally decided, and fixed the indemnity bond to be given by the city at $6,000. The city, claiming that the defendant was without right to string wires on the city poles and without right to string them on poles of its own in the streets and alleys of the city, commenced this action to perpetually enjoin the doing of the same, and obtained the temporary restraining order now on in the case.

TRANSMISSION.

Sandon, B. C.—The Sandon Water Works and Light Company, by J. M. Harris, Manager, has published notice that it will apply to Lieutenant Governor for sanction to take and divert 100 inches of water from Tributary Creek, at a point about half a mile or less from the junction of said creek with Carpenter Creek.

Marysville, Cal.—Supervisor Conrath has acquired land which gives him the water right to the power of the Yuba river at Deer Creek Narrows, a short distance east of Smartsville. This water has been turned over to the Marysville and Nevada Power and Water Company, which proposes to build a 100-foot stone dam in the narrows for impounding water for a transmission plant via Brown's Valley, Smartsville and Bonanza Ranch.

San Francisco, Cal.—The Abner Doble Company, agents of the Walker Company, are erecting for the Pacific Power Company, a 300 kw. 500-volt Walker multi-polar generator direct coupled to a Williams triple expansion central valve vertical engine running at 300 revoutions per minute.——Prince Poniatowski has returned from London, accompanied by Edmund Davis and Percy Tarbutt, who have become interested in the California Exploration Company. The company has secured the services of John Hays Hammond as engineer, and has about perfected arrangements for the installation of a transmission plant taking power from the Amador ditch, the Sparanza ditch, and another ditch five miles long between the Mokolumne river and the Tripp water right: 4700 horse power is said to be available.

Sonora, Cal.—Paul Jarboe and J. J. Grooks of San Francisco have purchased a controlling interest in the Tuolumne Electric Light and Power Company, the price paid being reported at $125,000. The new controllers of the company will at once take steps to enlarge the plant, and have already contracted with the Rawhide, App and other mines in the vicinity to furnish them with power. Many more mines have signified their intention of replacing steam and water power by electricity.

Lightning struck the plant of the Tuolumne Electric Light and Power Company at Columbia on July 17th, burning out the equipment and shutting down power for the Rawhide mine, as well as the lights in Sonora and Columbia.

Salt Lake City, Utah—The plant of the Big Cottonwood Power Company was placed in operation on June 4th, which marked the inauguration of one of the most important electric power installations in the country. The station is located in the Big Cottonwood Canyon, where 3400 cubic feet of water per minute is available at the lowest stage delivering a minimum of 2450 horse power. The water is conveyed through about 2,000 feet of 48-inch plate steel pipe line, steel varying from one-quarter to three-quarters of an inch in thickness to four 60-inch Pelton wheels which run under a head of 370 feet and deliver 650 horse power each at 300 revolutions. These wheels are direct connected to four General Electric three-phase generators and special Pelton wheels are provided for the exciters. The transmission is at 10,000 volts. The power thus generated is transmitted to Salt Lake City and used for running an extensive street railroad system, as also for lighting the city and for general power purposes. An additional water supply is available, which it is proposed to utilize later, increasing the capacity of the station to 5,000 horse power. The works have involved an outlay of something over $500,000, all of which has been furnished by Salt Lake capitalists. Contracts for power have already been made—amounting to more than $100,000 per year, with a very considerable surplus of power yet to be disposed of. It is expected that the investment upon the present basis, will pay not less than 20 per cent per annum over and above all operating expenses.

Murphys, Cal.—I. H. Linn and George Batten have received a county franchise for the generation of transmission of electric energy from a plant situated on the Stanislaus river at or near the junction of the Middle Fork and the North Fork of the said river. A water right of 5,800 inches has been secured and the head available is 1,208 feet to develop which it will be necessary to build a ditch about thirteen miles long, which will cost $77,000.

Phoenix, Ariz.—The Mesa Consolidated Canal Company, which owns some of the largest irrigating ditches in the Salt River Valley, has constructed a canal and power house in the original Mesa Canal, and has installed a 500 horse power turbine, from which will be operated a General Electric three-phase generator. The power thus generated will probably be utilized in the towns of Tempe and Mesa. Dr. A. J. Chandler is president.

Fresno, Cal.—The San Joaquin Electric Company is receiving the hearty support of local industries and in addition to the power contracts it now holds, principal among which is for the delivery of 150 kw. of power for the Sperry Flour Mills and 60 kw. for the Fresno Water Company, it has placed electric power in a number of local industries in barley mills, laundries, vineyards, and will also operate the new raisin seeding plant.

San Diego, Cal.—J. D. Schuyler, C. E., has presented a report to the municipal ownership club on the various water sheds and reservoir sites in the county available for a municipal water works. The report suggests the feasibility of deriving 1,100 horse power from the water supply.

Redding Cal.—It is stated that W. C. Brunsn of San Francisco is manager for an Eastern syndicate that proposes the installation of an electric plant operated by water power from the Pitt river. The scheme contemplates the erection of an electric smelter for reducing the ores of the iron mines on the McCloud river and the building of a railroad from the mines to the smelter. It is stated that the preliminary work is under way and that about 1,500 men will be employed in the execution of the plan.

Minersville, Trinity county, Cal.—The Minersville Hydraulic Gravel Mining Company, is contemplating the erection of an electric transmission plant operated by water power next spring.

Redlands, Cal.—The Redlands Electric Light and Power Company is figuring on the installation of a 350 horse power steam equipment to be used as an emergency plant.

Juneau, Alaska.—George L. Grant has been appointed general manager of the Alaska Electric Light and Power Company. The company is enlarging the capacity of the plant to 3,000 16-c.p. lamps.

Sacramento, Cal.—The Westinghouse transmission plant being installed by the Central California Electric Company and running from Newcastle to Sacramento, a distance of thirty miles, consists two 400 kw., 400 volts two-phase generators, delivering current through suitable station switch board to step up transformers which deliver three-phase current to the line at a potential of 15,000 volts. The lines are carried on Fred M. Locke's triple petticoat china insulator supported by 40-foot cedar poles. The Sacramento distribution will be of the two-phase system.

Spokane, Wash.—Mr. A. F. Burleigh, of Methow, who recently bonded the Monitor mine, together with other capitalists of Seattle, contemplate building an electric supply plant to furnish power and light to work the mines in this district and also to build reduction works to treat the ores.

Butte, Mont.—L. L. Nunn and others of Colorado have made several trips to Madison county, where they have been looking up water powers for the generation and transmission of electricity for various purposes.

Bridgeport, Cal.—The Chronicle-Union states that surveys of the river below town are being made and assumes therefrom that the long talked of electric transmission plans for working the Bodie mines is about to materialize.

Sacramento, Cal.—A 50 h.p. 500-volt Tesla motor now runs the State printing office.

MISCELLANEOUS.

City of Mexico, Mex.—Prominent gentlemen of Birmingham, Alabama, are contemplating the establishment on a large scale of works for the manufacture of mining and electrical machinery. The plant is expected to cost about $100,000 and will be established in the city of Aguascalientes.

Fresno, Cal.—Ordinance 326 has been adopted fixing the compensation to be paid by house movers and others for cutting aerial electric wires, as follows: For each electric light of No. 6 gauge and over, cut, raised or lowered, $1.50; electric power wires of No. 6 gauge and over, $2.50 each, and not exceeding $2 for each wire less than No. 6 gauge; telegraph or telephone wires, one wire only, not to exceed $1; two to six wires not exceeding $5; seven to twenty wires not exceeding $10; over twenty wires not exceeding $20; for telegraph or telephone cables which cannot be lowered or cut, the actual cost of raising the same.

San Francisco, Cal.—The following records were made by the members of San Francisco Union No. 6, of the National Brotherhood of Electrical Workers during the contests at the second annual picnic: The gold medal for the championship of the Pacific coast was awarded to J. A. Cameron, who climbed a 45-foot pole in 16 seconds; second prize, J. J. Cameron, 16 3-5 seconds; third prize, George Frost, 16 4-5 seconds. Cross-arm contest—First prize, A. Wagner, 2:27; second prize, F. Christ, 3:03 2-5; third prize, G. Frost, 4:58 3-5. Hand-line throwing contest—First prize, won by W. Bentley, rope on ground 3 feet; second prize, Jack Cameron, 2 feet 10 inches. Country climbing contest—First prize, J. J. Cameron, 0:30 1-5; second prize, J. A. Cameron, 0:33 2-5; third prize, George Frost, 0:34 3-5.

Salt Lake City, Utah.—The hot air bath of the sanitarium is now heated by incandescent electric lamps.

The Journal of Electricity

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Flec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

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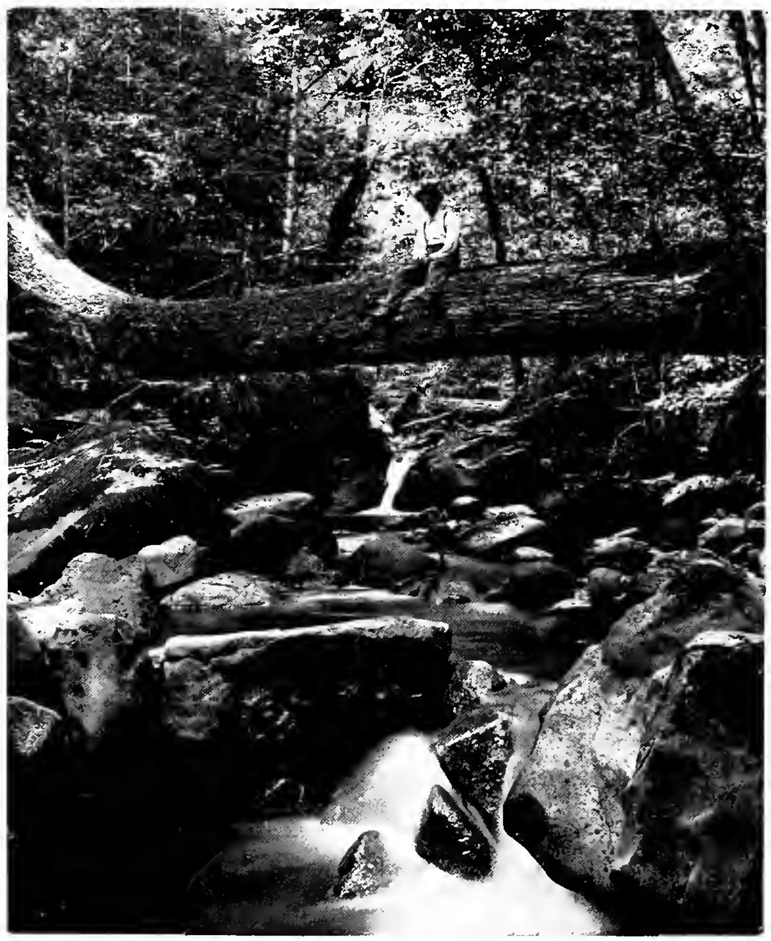
The Big Creek Power Transmission

For some time it has appeared to the electrical engineers of the Pacific coast that the energies of the transmission department of the Westinghouse Electric and Manufacturing Company have been centered in the great undertaking at Niagara Falls for the reason that during the past three years the Westinghouse Company has accomplished practically nothing in the way of long distance transmission in the far West, although actively engaged in the middle and Eastern States. It is true that the Westinghouse Company was the pioneer concern to engage in transmission undertakings on the coast, as the interesting installations at Portland, Telluride, Bodie, and Pomona attest, and it is probable that no single installation gave a greater impetus to electrical transmissions than did the successful achievement of the Westinghouse Company in the San Antonio plant in stepping up to 10,000 volts for long distance transmission purposes. Of late, however, the influences of the company have again been making themselves felt in this sphere, for it has now not only installed the transmission plant of the Big Creek Power Company of Santa Cruz, Cal., but will shortly place in operation the plant of the Central California Electric Co., extending from Newcastle to Sacramento and employing the unprecedented potential of 15,000 volts.



BIG CREEK, SANTA CRUZ COUNTY, CALIFORNIA.

A significant feature of Westinghouse transmission plants, is the fact that the apparatus used presents no marked external deviation from old and familiar types. The generators, transformers and switchboard equipments are all of familiar forms and the only difference presented is in their windings. Two-phase generation is strictly adhered to as is also the system of three-phase transmission and two-phase distribution. The two-phase generation is converted to three-phase current for transmission purposes by means of the Scott system, the reason for the change being that three-phase transmission effects a saving of approximately 25 per cent in copper over two-phase transmission. Except for the motors, which are of the Tesla type the distribution is practically identical with that of any single phase alternating system, and in the Santa Cruz installation of some 3000 incandescent lamps which had been operated on the alternating system, the existing circuits were connected to the two-phase switchboard without material change in one day. A description of a Westinghouse transmission plant becomes, therefore, one of power development rather than of electrical equipment.

The water for the operation of the Big Creek Power Company is derived from Big Creek in the Santa Cruz mountains and a characteristic photograph of which appears on page 1. The minimum capacity of the creek under existing conditions is about 500 horse-power, but the site has already been secured for an impounding reservoir which will increase the minimum capacity to 1000 horse-

FLUME OF THE BIG CREEK POWER COMPANY

power all the year round. At present the creek has an available capacity of 2500 horse power for eight months in the year..

The entire equipment for power development is in a heavily timbered country consisting largely of mammoth redwood trees and the first illustration on page 2 shows the manner in which the flume is carried along mountain sides in order to obtain the desired head. Along each side of the flume is shown a line of 4x6 timbers. These formed the wooden rails on which were run the construction cars for carrying lumber and supplies during the building of the flume.

The plant works under a head of 923 feet to obtain which was constructed the wooden flume, 11,125 feet long and having a depth of 18 inches and a width of 30 inches. The flume was built of one-inch redwood boards doubled with lapped joints. From the penstock the water is carried for 1930 feet of leaded and banded joint pipe of the following dimensions, beginning with the penstock and continuing towards the power house:

965 feet of 16-inch No. 12 iron pipe.
370 feet of 14-inch No. 10 steel pipe.
200 feet of 14-inch No. 8 steel pipe.
200 feet of 14-inch No. 6 steel pipe.
200 feet of 14-inch No. 5 steel pipe.

Some of the diversified means employed for supporting the pipe line are shown in the second illustration on page 2, which also clearly illustrates the manner of making joints in the pipe line.

The power house is the small temporary wooden structure erected at the foot of the hill as illustrated on page 3 and the equipment it contains at present consists of a 46-inch Pelton wheel having a capacity of 500 horse power at 600 revolutions per minute. The wheel is contained in iron casing and is designed to operate one 150 kilowatt generators on each side. At present but one such generator has been installed and this is a Westinghouse two-phase machine, operating at 1100 volts. The switchboard is of the well known Westinghouse marble and angle iron panel type, with the addition of being equipped with high tension plunger type switches. All current carrying parts are behind the board, hence on the surface appears only insulated devices by means of which the switches are actuated, thus insuring immunity from personal contact. From the switchboard the 1100 volt current is conveyed to two 75 kilowatt self-cooling transformers, operating in parallel and by means of which the potential is raised for transmission purposes to from 10,000 to 11,000 volts, according to load.

Round redwood poles are used as shown in the illustration on page 3. These poles are 30 feet long, are set approximately 40 to the mile and each carries two cross arms, the top one being a four-pin and the lower a two-pin arm, thus providing for two three-phase circuits. At the time the photograph was made but one three-phase circuit had been erected, but now the second three-phase circuit has been completed. The wires consist of No. 5 Brown & Sharp gauge bare copper wire, which are "barreled" or transposed at every pole. Immediately below the lower cross arm is carried the telephone circuit, which is sprung on brackets and transposed every fifth pole, and conversation is carried on between the power house and the sub-station, a distance of 17 and one-third miles, with ease.

The sub-station, which is located on the ground floor of the Pilot Building in Santa Cruz, contains transformer and switchboard equipments practically identical with those at the power house, and in addition the switchboard carries panels of four two-wire distributing circuits of from 1000 to 1100 volts. The entire output of the Big Creek Power Company is at present sold in bulk to the Santa Cruz Electric Light and Power Company, which, in shutting down its steam plant and contracting for the output of the Big Creek Power Company, has appreciated the wisdom of averting the results that were threatened by competition from the transmission company.

The Big Creek Power Company has recently placed an order with the Westinghouse Company for the duplication

A PORTION OF THE BIG CREEK PIPE LINE

THE TRANSMISSION

of the plant above described, which will give a total of 400 horse power in generator capacity at the power station. These two two-phase generators are to operate in parallel supplying current to a common circuit and the generators are to be coupled direct to the water wheel by means of specially constructed friction clutches. As the power house of the Big Creek Power Company is but 26 miles from San Jose, the company is considering the feasibility of transmitting a portion of its surplus power to that city.

POWER FROM SMALL MOUNTAIN STREAMS.

There is a growing tendency among the miners and exploiters of mines in the western part of the United States to utilize as motive power streams which not so very long ago would have been considered unworthy of consideration as sources of power. Men are beginning to learn that head counts as well as volume, and that a tiny stream with several hundred feet head may be as valuable a source of power as the more imposing fall of much lower head. Then, too, the little stream needs no expensive dam or head works to confine it, but can be trapped and guided at comparatively small expense, and instead of being allowed to fall freely, it can be led into a pipe which impounds it all, and thus it can be confined and led perhaps 500 to 1000 feet down the mountain, accumulating pressure as it descends until it shoots out with full force against the buckets of the Pelton wheel, or quietly exerts its statical pressure in the chambers of a direct air compressor.

Not so very long ago the writer saw a plant being installed over eight thousand feet up in the Rocky Mountains, and the primitive pipe-making establishment was very interesting. Rather than incur the expense of hauling the wrought pipe, a small pair of bending rolls had been procured, and these, with a portable forge, constituted the equipment. Under a frame shed by the mountain side three men were turning out length after length of riveted sheet-iron pipe, right at the place where it was to be used, and the pipe line was being constructed five hundred feet up the canyon, bringing down over two hundred horse power to the spot where it was to be utilized. The operations seemed somewhat primitive at first sight, but the expense account of the establishment was a minimum, and when the cost of burro train and the railway freight, and the profits of several middlemen were taken into account, the miners were probably ahead in the long run.—Cassier's Magazine.

SATISFIED WITH 220-VOLT LIGHTING.

Mr. O. E. Goodale, General Superintendent of the National Home for Disabled Voluntary Soldiers of Santa Monica, Cal., is authority for the assurance that the 220-volt incandescent lighting plant in operation at that institution is "very satisfactory indeed."

As briefly outlined in the news columns of The Journal several months since, the plant consists of a Siemens-Halske 55-kilowatt 220-volt generator direct connected to a 9½x15x8 Union Iron Works vertical engine running at 380 revolutions per minute, and from which are operated circuits over the extensive grounds for lighting 1350 incandescents and 12 Manhattan arc lamps. The distribution extends one mile from the station in one direction, and three-quarters of a mile in another direction, and the voltage at the generator varies from 220 to 242 according to load. At the outset some trouble was experienced in the use of ordinary 110-volt cut-outs, and sockets, but the trouble with the cut-outs has been obviated principally by reducing to a minimum the size of fuse wire used in order to prevent the maintaining of a heavy arc due to excessive amperage in blowing

TEMPORARY POWER HOUSE

layer fuses from, and in the sockets by increasing the separation between the tongues of the Edison sockets and the caps of the lamp bases.

Of all the American technical journals it is safe to assert that none is received with more pleasure or satisfaction in every branch of science and engineering, than is the Scientific American, which has just marked its Golden Anniversary by the publication of a very handsome 72-page, special number, consisting of a review of the development of science and the industrial arts in the United States during the past 50 years. Filling as it does a niche which can be occupied by no other publication, the Scientific American can feel assured of the congratulations of its countless admirers.

Electro-Insurance.

THERMOSTATIC FIRE ALARM TELEGRAPHS.

BY GEORGE HERBERT STOCKBRIDGE

To such as have not followed the recent history of fire alarm telegraphy, the knowledge of the progress made within the past few years in the automatic announcement of fire will come as a matter of some surprise. The general features of the automatic service are well enough understood: (1) The employment of thermostatic circuit controllers in the protected building; (2) the use of a local signal box (preferably outside the building) under the control of a retaining magnet operated by the thermostats, the said signal box being capable not only of signaling the number representing the building, but also of designating the particular section in which the operating thermostat has been set in action; and (3) the maintenance by the company giving the service of a central office of its own through which the true fire alarm signals are sent to the fire department either manually or by automatic repeaters. The later improvements have not greatly changed these general features; they have altered, however, the character of the service rendered and have made an inefficient protective apparatus for buildings into one that can be relied upon to act more quickly and more surely than a faithful watchman: for every thermostat is a watchman just as faithful, and having directly at hand the means for signaling, and sure to be on the spot when the fire takes place.

It is on record that an automatic system in a Western city employing mercurial thermostats, sent in 195 false alarms out of 203 actually transmitted. By another record, elsewhere, 55 false alarms of a total of 57, were charged against another apparatus. It was also not unheard of in the early days for an employe to be sent around to the box from which an alarm came in, to see with his own eyes whether there were any signs of fire about the building. If there were not, he simply lay low and awaited developments; if there were, he would hasten to turn in an alarm from the nearest street signal box or run back to the company's central office and transmit the alarm from there. But stories like these are quite out of date. The fire department now responds to the calls of the perfected automatic systems with the same confidence as to those of the manual service. In truth, there is more danger of false alarms from the mischievous propensities of the school-boy than from the fallibility of the best thermostatic telegraphs.

The interests now represented by the industry under consideration have, from small and discouraging beginnings, become large and important. The growth has been fostered by the fire insurance underwriters in our various large cities, who very early saw the importance of encouraging an agent which promised to lessen fire risks in a very appreciable degree. The basis of their support was that a smaller rate on a good risk is more profitable than a large rate on a bad risk. A half million dollars in premiums is two-thirds gain or no gain whatever, according as the payments for fire losses are few or many. It is not the actual total of the premiums that counts on the profit side; it is what remains of this total after the fire losses are made good. The surest way to show the right kind of a balance sheet in insurance matters is to put safeguards around the risks, even if it should involve a considerable cutting down in the column of moneys received. It is precisely for this reason that the fire underwriters have given to property-owners making use of the automatic service a rebate (usually 10 per cent.) on the full normal premiums.

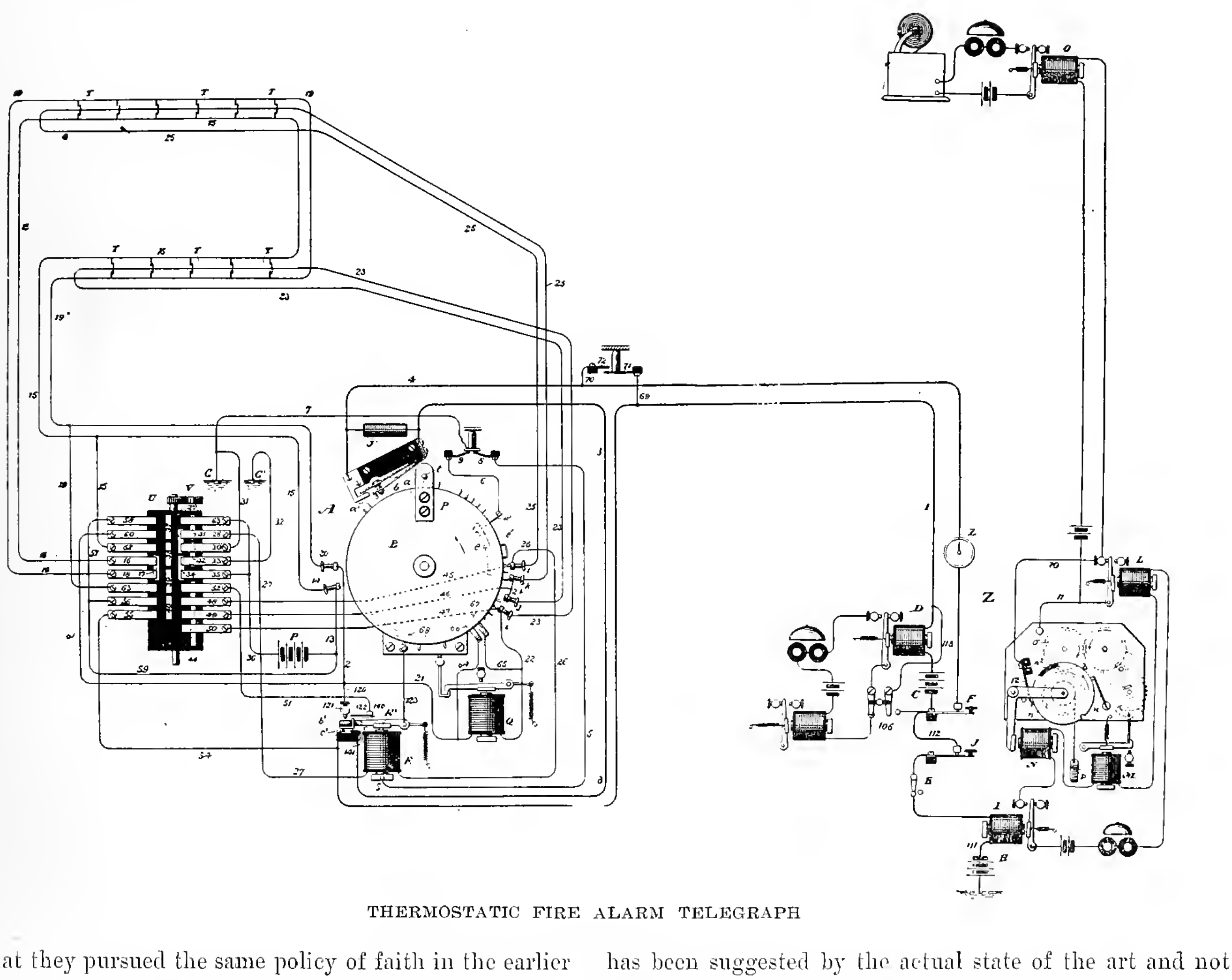
The wise—not to say generous—business policy of the underwriters in recognizing the value of the automatic fire signal as improving the quality of the risk cannot be too highly commended. That this policy has received ample justification must be a gratifying sequence of much undeserved criticism. Statistics are not at hand to show anything like the exact amount of property protected by automatic fire telegraphs, but the large number of instances in which fires reported by them have caused only nominal damage is indicative of their admirable efficiency. Of course the dry goods merchant or the varnish dealer, in computing his risk from fire takes into the account not only the destruction of his property, but also the interruption to his business, with its inevitable loss of old and valued patrons. Often this is more serious than the annihilation of values caused directly by the destructive element. Bearing this in mind, no exact estimate of total losses and probable saving is any way possible.

Almost without exception, however, the automatic alarm is the first to arrive, and in some instances it comes in many minutes before any visible signs of fire, such as would cause a manual alarm to be sent in, appear. As the automatic signal locates the source of heat within a definite part of the building, no time is lost in applying extinguishers immediately at the point where they will be most effective. It is needless to say that the few or many minutes gained at the beginning of the fire are by far the most precious of all in the way of preventing losses.

A still more potent factor in the reduction of fire losses is the capacity of the best equipped automatic system for preventing fires by giving warning at the company's office of the occurrence of undue or dangerous heat at the protected building. In not a few cases, heat that threatened

to result in fire has been called to the attention of the company's employees and fires have been averted by the removal of the causes of the heat. In one instance, in Baltimore, a "trouble" alarm having come in, an investigation disclosed the fact that a stove in Messrs. Fleet, McGinley & Co.'s record printing house was in a red glow and in danger of firing the premises. The building was carefully watched by representatives of the company doing business in Baltimore, until all danger was over. The development of the automatic fire alarm telegraph to the point where it not only signals the occurrence of fires with quickness and certainty, but also serves to prevent fire, is surely a splendid justification of the faith of the fire underwriters.

discrimination, indeed, there exists precisely the same warrant as for any concession whatever in favor of protected structures. However, as already stated, the faith of the insurance underwriters and their willingness to act upon their faith by practically assuming their share of the cost of instituting the automatic system have exercised a fostering effect upon the development of such systems. Curiously enough, however, the improvements in the art, have, as a rule, preceded the demand of the underwriters, the actual needs of the service constituting a stronger appeal than any other. If the history of the case be studied, it will be found that the adoption of more stringent underwriters' rules for the installation of automatic fire alarms



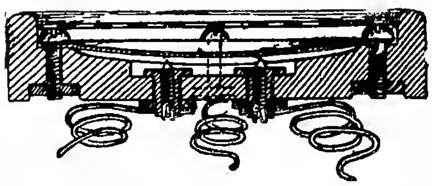
THERMOSTATIC FIRE ALARM TELEGRAPH

That they pursued the same policy of faith in the earlier days when the automatic signal gave such a poor account of itself, can probably be explained on the ground that a few false alarms, more or less, did not particularly matter to them. But when the fire department, to whom it did matter, began to respond less readily or not at all, to the thermostatic alarms, the demand for an improved service became loud and urgent, and nowhere more so than among the underwriters themselves. If there is any criticism to be passed upon the present attitude of the underwriters, it is that they are, we will not say, over-generous to systems affording inferior protection, but that they do not discriminate in the amount of the rebate conceded, between systems offering distinctly different grades of service; for which

has been suggested by the actual state of the art and not by the possibilities of the art and the needs thereof, as conceived of by those having the interests of the insurance companies in charge. Our present improvements can be traced to the unenforced appeal of the needs of the situation as discovered by the inventors themselves after testing inferior apparatus. In the struggle to adapt itself to its environment the evolution of a great and benificent invention has proceeded by due course of nature.

To begin with, the old mercury and solder thermostats were totally unreliable under the conditions which they have had to meet. The tremors to which large buildings are liable were sufficient to set off the former instruments. The latter suffered great alterations through the deteriorat-

ing effects of time. Besides this the mercury thermostat is fragile beyond what is fairly useable in the ceilings of factories and similar buildings. It is no longer considered available for this work, and in places where it has been longest in use it has finally been positively thrown out. The solder thermostat is still admitted under certain restrictions as to the composition and the quantity of the solder. But the tests to which the thermostats in situ are liable to be



AUTOMATIC FIRE ALARM TELEGRAPHS—SECTION OF A THERMOSTAT

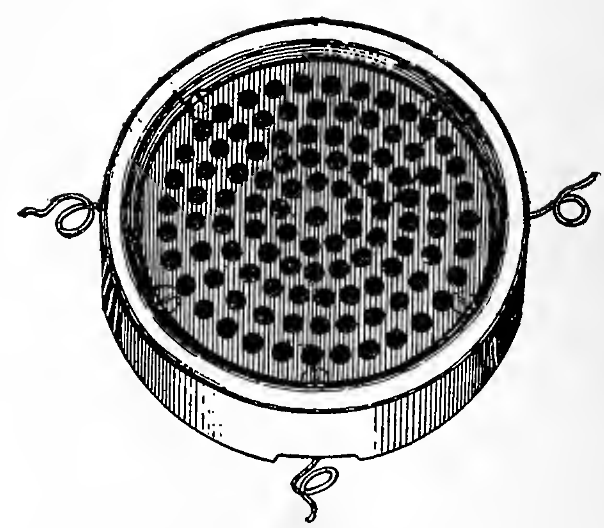
subjected are jointly very much against the preservation of their mechanical and electrical integrity, and few of the list are entirely satisfactory. Should they withstand being broken or detached by the whitewash brush, they still run a fair chance of being deranged or incapacitated as circuit controllers by the whitewash itself. This leaves out of the account the chances of the oxidation and corrosion of the contact points, and of severe and sudden over-heating; it overlooks the dangers arising from jarrings and vibrations, and from accumulations of dust and dirt; and, in general, it neglects the deterioration of age. Altogether, the fire alarm thermostat must preserve its reliability under tests to which no other sensitive instrument is subject.

As to other qualities, it must generally show a fair degree of accuracy, the requirements in this respect being considerably less however, than the state of the art would permit. Besides, it is usually expected to be capable of adjustment within wide limits, say from an upper limit of 350 degrees Fahrenheit to a lower limit of 160 degrees when serving for fire signaling purposes only, or of 125 degrees when adapted to the service of announcing undue heat for the purpose of preventing fires. I have before me a sample of a thermostat embodying some of the latest ideas in this art. I find it made up of a solid porcelain base carrying one circuit terminal, while the expansible element constituting the opposite terminal is a concavo-convex metallic diaphragm having a flat rim and firmly held at the rim to the base. Outside the thermal or expansible disk is a perforated plate designed to protect the thermal disk from mechanical injury, and at the same time to leave the disk open to the influence of the surrounding atmosphere. Such a thermostat is not at all disturbed by jarring, nor is it likely to receive injury from any of the other accidental or natural causes enumerated above. Yet, owing to the large surface and the small mass presented by the thin expansible disk, its action is very quick and certain. Thermostats of this type have been in successful use in seven or eight of our large cities for several years. To illustrate the sensitiveness and accuracy of these instruments reference may be made to a test instituted in April, 1889, in Cincinnati, by a committee of the Louisville Board of Fire Underwriters. A selection of eight thermostats, each marked with a number representing the degree of heat (Fahrenheit) at which it was expected to operate, was placed in a box prepared for heating and subjected to a gradually increasing temperature, with results indicated by the following table:

Thermostat No.	Temperature indicated.	Temperature at which signal was given.
1	141	141
2	139	139
3	139	140
4	139	140
5	148	148
6	150	149
7	152	151
8	152	152

This accuracy of action, in itself, perhaps, not particularly remarkable, was made so by the character of the thermostats tested—their strength and durability. In view of the showing here made, it is not too much to say that the up-to-date automatic fire telegraph system is under the control of an instrument as sensitive as a thermometer and as strong as a manual signal box. It is no longer a source of trouble to the city authorities and of annoyance to the property-owners. The improved thermostat has been an important factor in changing all that.

But apart from the thermostats other and quite as important improvements have been wrought by novel circuits and by various remodelings of the system as a whole, and of its other constituent elements. With the old open-circuit organization, employing mercury or solder thermal devices, the happy apportionment was hit upon, that the thermostats should be responsible for the false alarms and



THERMOSTAT OF AN AUTOMATIC FIRE ALARM TELEGRAPH SYSTEM

the faulty system of circuits should bear the blame when no alarm at all was sent in. The change to a closed circuit arrangement adapted to give automatic notice of the rupture of a wire, the exhaustion of the battery, an accidental ground, or a dangerous cross, was the first advance step. It is an absolute essential. Yet in its simplest form,

wherein all the thermostats, together with the retaining magnet for the local transmitter, are in a straight closed system, it would be impractical, because the proper action of a thermal circuit opener under heat could not be distinguished from the mentioned accidental troubles.

It was necessary, therefore, to differentiate the effects of a thermal action and these various accidents. Starting from the notion of including the contact points of the thermal circuit-controllers in the signaling circuit, the transmitter was arranged to send a fire signal only upon the thermostat's first breaking and afterwards making an electrical contact. A simple rupture, or a cross, or a battery failure would send a signal, it is true, but something other than a fire signal. However, since the object of the closed circuit is primarily to provide an automatic warning of some derangement of the circuits (for the thermal circuit controllers, as such, work no better with one set of circuits than the other) it is found unnecessary to run the original closed circuit through the thermostat contacts. It is chiefly important that it should traverse the retaining magnet which holds the local transmitter mechanism. By these means all serious trouble is signalled to the company's office without regard to the thermostats. The distinctive signals resulting from their operation by undue heat or by fire may be provided for in other ways. Being familiar with all the details of a system embodying the last mentioned features, I have chosen it for an illustration of what is latest and best in this line of progress. The choice is made without prejudice to any other organization doing the same class of work.

The thermostats, which appear in the diagram at TT, are identical with those already described in connection with the Cincinnati test, except that in each, the expansible element co-operates with two contact points, one more remote than the other. When exposed to a dangerous heat, the thermal disk first makes contact with the nearer point, thereby short-circuiting the retaining magnet of the signaling mechanism. By the release of this mechanism, a signal is transmitted from the protected building, where the described elements are located, to the company's central office at Z. The character of the signal thus sent is determined by the distance through which the signal wheel of the mechanism B is permitted to rotate; that is, by the number of circuit changes effected by the action of the teeth of wheel B upon the contact springs a and b. Should the heat which caused this partial operation of a thermostat be a slow heat, not resulting from an actual burning of the building, nor immediately causing such a burning, the signal sent by it will be regarded as a "trouble" signal and the trouble will speedily be removed by a messenger from the company's office. Meanwhile, the described partial operation of a thermostat has caused only a temporary short-circuiting of the retaining magnet, the circuit through which is restored when the wheel B has traveled far enough to make the arm P operate the switch 20 or the switch 14, as the case may be—the former if the action of the thermostat has joined wires 19 and 25, the latter if the wires 15 and 23. On the other hand, should the temperature continue to rise until it reaches the fire point and closes the second contact of the thermostat, the signal wheel will travel until the arm P shall have operated one or the other of the switch pairs i j, or k l. In the first instance, the wheel B will have sent in the building signal (which, in the illustrated apparatus, is 35) twice repeated and one of the single pins behind the number groups of pins will have operated the circuit, thereby indicating the first story as the place where the fire is to be looked for. In the second instance, the second story will have been designated by the repeated number signals followed by two separate single signals. Manifestly in these four different operations the signal wheel is carried to four different points, while the normal position coincides with neither of them. Accordingly by putting an annunciator dial in front of the mechanism B, and a pointer to travel over it, the condition of the local apparatus can always be known at a glance. This is now required by the rules and the local apparatus must be placed upon the outside of the protected building, where every passer-by becomes a spy upon it.

Without attempting to trace the circuits, I may say that the system includes both a metallic and a ground circuit with separate receiving apparatus in both and that the arrangement contemplates the reception of each element or unit of every signal over these two circuits alternately, each acting as a check upon the other. The springs a. and b. control, respectively, the ground and the metallic circuits, co-operating for that purpose with the teeth upon the signal wheel. The receiving apparatus contained directly in the metallic circuit is the relay D which controls a local alarm and register in an obvious manner. The ground circuit receiving apparatus is the relay I, and this controls a local alarm and register and a group of circuits leading to the fire department at O. It is clear that by means of the successive teeth, actuation of the springs a. and b. by the signals will be received at the company's central office on both sets of receiving apparatus, the elements or units of each signal being received alternately on the one and the other. To permit the actuation of the spring a. without interfering with spring b., the former is supplied with an insulating pin which projects through an opening in the latter.

Now as to the repeating of the fire signal to the fire department, it is brought about by means of the long tooth e2 on the wheel B. This tooth does not strike the contact springs a. and b. until after all "trouble" signals have been sent in, whether from the partial closure of a thermostat or from the running down of the battery P, the breaking of one of the circuit wires, or the crossing of two wires or an accidental ground—all of which temporarily short-circuit the trip-magnet Q, leaving the circuit to be restored by one or the other of the switches 20 or 14. The tooth e2 keeps the circuit closed for a considerable period during which the magnet I holds to armature or its forward stop. This suffices to release the clock-work o. and set the disk u. in motion maintaining it till the catch u. engages with a notch in the said disk. Thereafter, signals received on the magnet I. will be repeated to the fire department at o., to be there sounded and recorded upon suitable apparatus.

It will be observed that the protected building or local station is provided with a series of main or building wires and a series of section or loop wires extending through the structure. The two groups of wires are in series on opposite sides of the trip magnet, so that a cross between two or more of them will cut out the said magnet and release the mechanisms. By virtue of the loop arrangement true fire signals will be transmitted even when grounds or crosses may exist and though all the building wires were broken.

Although the described circuits appear somewhat complicated, yet the wiring for a large city, say New York, even, would be no more complex than the wiring required for five telephone circuits.

No allusion has been made to automatic systems having no central office and connected directly with the municipal fire alarm boxes, because they are looked upon with general disfavor and are already reckoned among the things of the past. The tendency is more and more to make the company maintain an office at its own expense which shall relieve the fire department of all responsibility for the system. In effect, these central offices, supported by private enterprise, are an undoubted saving to the municipalities, particularly in the way of preventing fires, as above set forth. As they multiply their operations, they will increasingly lighten the work of the department, and be as welcome as they were formerly despised.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

ELECTRICITY IN MINING APPLICATIONS.

Despite the many cheap water powers in the neighborhood of most of the California mines, it has often been remarked that comparatively little use has been made of electricity in working their machinery, and even where this means of transmitting power has been employed for the operation of surface works the wires have not been laid underground for the operation of deep-level machinery. On the other hand, when we glance at the mining situation in the East we find far greater use made of electric power, and there has been a consequent tendency to charge our mining engineers with a lack of progressive ideas. Such a charge, however, need only be made by those unfamiliar with the problem of deep-level mining and with the condition of electric mining machinery at the present day. In the coal mines of the East cutting has to be done only through the coal itself or through very soft slate rock, and in consequence the seams to be broken out can be undercut with revolving cutters, and the holes for blasts sunk by motor-driven augurs; also, we find that by far the greater quantity of coal is taken out of such mines by the means of tram haulages over sloping tracks. These conditions allow the employment of high efficiency motors in cutting and drilling, and admit the use of the current all along the shaft from its mouth to the lowest workings; in consequence the installation of conductors is not difficult, and the system is capable of delivering to the various machines a large amount of power per pound of conductor.

Deep-level gold mining, on the contrary, is not performed by drifting, but by sinking vertical shafts while the workings themselves are generally in exceedingly hard rock. In consequence long leads from the generating plant must be led to the first machines and the conducting cables are continually saturated with dripping water highly impregnated with sulphuric acid from the ores and acetic acid from the timbering which continually destroy the best qualities of insulation that have been produced. Furthermore, such mines must be ventilated with great care and the air used in compressed air drills is of advantage in working, both for ventilation and for coolness. At the same time we believe that the use of electricity for operating the surface machinery is much hindered by a lack of electrical knowledge on the part of mine superintendents. These workings are always among the hills and generally far from a base of supplies and repairs, consequently a mine cannot economically use electric machinery unless either the mine superintendent is himself an electrician or a separate competent electrician is employed. The cost of two men having the respective positions of mine superintendent and mine electrician cannot be borne by many mines with the present low margin of profit in operating, and we will consequently not see an extensive introduction of electricity in mining until those who are capable of handling the machinery become mining engineers, or until mine superintendents shall have learned the care of electrical machinery just as now they understand the care of steam engines, air compressors and stamping plants.

HIGH FREQUENCY EXPERIMENTS

One evening after Tesla had been exhibiting some of the wonderful phenomena produced by his high frequency currents and displaying vacuum tubes without electrodes illuminated by induction from the current flowing in a neighboring wire, he was asked if it would be possible to so insulate the leads in this system of lighting as to prevent unauthorized use of the current, and he replied that a covering of hard rubber one foot thick would do the insulating very nicely, provided that the dielectric would not succumb to the heat generated in it. Though this remark was made more than four years ago, and though Tesla, Edison and McFarlane Moore have all made advances in the field of illumination with high frequency currents, there has been no means of distributing such remains to-day, as it has since the beginning of this line remains today, as it has since the beginning of this line of experimentation, without practical solution. Judging from the papers that have been published, Moore expects to employ current from an ordinary lighting system and to generate his high frequency currents at the points where they are used by the means of a specially devised interrupter. Tesla's plans have frequently been stated to embody the use of the oscillator generator requiring a distribution of high pressure steam and sometimes to embody the Tesla transformer with a spark gap interrupter. So far as is known at the present time, Edison has not attacked the problem of distribution, but has only concerned himself with the production of high frequency lamps.

All of these experimenters have obtained in their laboratories wonderfully interesting results and they have been enabled to produce startling effects of great brilliancy which have drawn to their preliminary experiments the attention of reporters from the daily press, the result being that where a more thorough knowledge of the problem is lacking, one is almost inclined to believe that we are on the verge of a great revolution in both the manner and efficiency of illumination. Indeed, it may be that we are soon to see the solution of the problem of economical illumination, but if this is true it will be through the agency of some discovery not less startling than the recently announced Roentgen phenomenon.

The problem is not, as the daily papers would have us believe, bounded by the production of an economical lamp along lines which have been experimentally developed in the laboratory, but is one that has not yet been attempted, that of the economical generation and distribution of high frequency currents. Until this problem shall have been attacked and a practical solution proposed, the lighting effects already obtained must be confined to the sphere of laboratory experiments, and however great may be their beauty and whatever theoretical efficiency we may calculate for the system of illumination, we can only expect to see their application many years in the future.

A MONOPOLISTIC BACKBONE BROKEN

The careful observers of the electrical situation on the Pacific Coast are not alone in having noticed the turn the tide is taking in reference to the prestige of the big manufacturing companies, for even the most casual onlooker can see that the conditions now existing are in marked contrast to those dominating a year or so since. Then one company alone maintained a well organized office in San Francisco. It had—and yet has—an efficient engineering corps, and by virtue of reliable apparatus aided most effectually by the utter absence of real competition from the remaining leading manufacturing concerns, the business of the company referred to forged ahead until by sheer force of circumstances its San Francisco office not only became the most profitable of all those maintained by the company, but judging from the sales made, it would seem that the people of the Pacific Coast really believed that no other concern could build reliable electrical apparatus. The attainment of this highly remunerative and monopolistic eminence was due to good management on the part of the home company in maintaining its San Francisco office, or to the absence of competition—either, as you will have it, rather than through local management.

A review of the situation leads to the conclusion that the other manufacturing concerns have long overlooked the business of the Pacific Coast, probably because of its remoteness; but be this as it may, it is certain that their attitude toward the Far West has changed from that of apathy to eagerness. Branch offices have been established, new and solid agencies have been created, heavy stocks have been and are yet being brought in, powerful combinations have been effected and the electrical interests of the Pacific Coast are now beginning to realize that other manufacturers put out apparatus that is just as reliable, just as efficient, just as satisfactory and just as cheap as that which they had begun to look upon as being the ne plus ultra. Almost daily evidences are received of the breaking away of local companies from the ties which had bound them to the one-time omnipotent electric corporation that carried their business as in its hand. The magic spell by which the business of the Market Street Railway Company, which is installing or has in operation several thousand horse-power of electric generators in the new Bryant Street power house, as well as by the Walker and Westinghouse Company, which have at last secured large orders for street railway equipments. The Sutro railroad bought the largest portion of its car equipment from these concerns. The Walker Company has placed a 400 Kilowatt railway generator in Oakland, and is erecting an 800 Kilowatt generator in Los Angeles, and now announcing that it is to establish a branch factory in San Francisco. The Westinghouse Company, in addition to scores of smaller contracts, has completed the Santa Cruz transmission plant described in this issue and will shortly place in operation the 15,000-volt transmission of the Central California Electric Company, running into Sacramento. The Stanley Company, too, has demonstrated to the people of the Pacific Coast the features of superiority of its system in the transmission plant of the Nevada County Electric Power Company, and is now installing a lighting and power plant in the heart of San Francisco, in addition to placing a 250 Kilowatt inductor alternator in Alameda. Hosts of independent supply companies are rising in every quarter and the quondam monopoly can no longer point to a single locality in California at least, where its strength is unassailed.

Electrical interests have occasion to rejoice at the turn of the tide.

Passing Comment

An Editorial Review of Current Events and Contemporary Publications.

CONCERNING CENTRAL STATION EFFICIENCIES

We have for some time been emphasizing the importance of considering the efficiency of a central station as the total "all day efficiency," rather than as its efficiency at full load and of the importance in station design and management of the character of the load to be carried. This question has been taken up in detail by Mr. E. A. Merrill in an article on "The Total Efficiency of Certain Central Stations" in the June number of Electrical Engineering, in which is considered four stations of different types and explains the best possible arrangement of station and the best economy that could be obtained

under different types of load. On comparing these with actual stations he shows that the best results obtained in practice are not within 7 per cent of that which should be expected under the conditions, in spite of the fact that there is no doubt but what station engineers carefully consider the possible efficiency of their engines, and dynamos in making their choice, and that this machinery is generally carefully managed by intelligent engineers.

The lesson to be read from such conclusions is that the study of design in a central station plant should be directed towards the condition of supply, rather than, as it is at the present day, towards a high possible full load efficiency. Certain circumstances connected with station operation tend to prevent a choice of the best possible arrangement of apparatus, among which conditions we note principally the requirement of an uninterrupted supply. In all reasonable contingencies of service this condition has up to the present time been met by the installation of duplicate apparatus and pipe systems. There seems to be no reason for this installation of many dulplicate parts, for it is possible to overcome every difficulty with apparatus having a greater factor of safety than is at present employed. Repeated tests have been made on the materials of construction which indicate clearly that there is no such thing as ageing of machines where the eleastic limit is at no time and in no part exceeded. In consequence, the requirements in the construction of a thoroughly reliable supply station might be as readily filled by the use of high factors of safety as by the present method of duplicate parts, and though such construction would naturally reduce the efficiency at full load, there seems to be no reason for believing that the total efficiency would not be improved by the elimination of losses which at the present time are classed amongst unknown quantities, such losses as those which are included under the general heads of steam pipe radiation, radiation of heat from unused engines, leakages from duplicate valve systems, as well as the losses which occur at times, of accidents, all of which at the present time are provided for by duplication, and not by strength.

LIGHTNING ARRESTERS IN THE FAR WEST.

We have already, upon several occasions, called attention to the fallacy in the supposition that the infrequent lightning storms of the Pacific Coast are harmless to electrical undertakings, and are now gratified to notice that Alex. McAdie has spoken of the necessity for lightning arresters on the street cars of electric railroads, though this may seem to be an extreme position to take, especially as central stations are not at the present time at all adequately protected.

The damage done during an electric storm to a street railroad system is comprised by the destruction of motors and consequent temporary interference of service, but there is not, as some of the daily papers attempt to show, an accompanying danger to the passengers. The interference to the service through damage to one or two motors, cannot certainly be compared with the destruction of even one generating unit at the station, but at the same time the alarm to passengers should a motor be destroyed by a lightning discharge, amounts to even more than the temporary stoppage, for the reason that such accidents will naturally prejudice the minds of juries in damage suits, besides fostering the fictitious damage suit which every railroad manager must desire to avoid.

Should the line of an electric railroad be efficiently protected by arresters the danger to the generating system and the likelihood of damage to cars is much reduced, so that whether or not the car arrester comes into use we must earnestly hope to see within the next few years a general introduction of lightning arresters along the lines of both railroads and lighting plants; while we feel that the damage already done to long distance transmissions in this State will ensure the introduction of arresters for that service.

Great care must be used in selecting the type of arrester to be used on the Pacific Coast, for the reason that its infrequent action will necessarily bring about a certain lack of care, and the dry, dusty season here will make that neglect fatal to certain types of apparatus. Further, lightning storms come to us with less warnings than in other localities where certain conditions of the atmosphere are invariably followed by such a disturbance, and in consequence, the arrester which must be put in service at need is not satisfactory, and again our engineers should not employ those arresters which consume large amounts of energy, since the comparative infrequency of the storms reduces the profitableness of the protection which they afford. Consequently the engineer who is adopting lightning arresters to be applied to the circuits of any central station upon the Pacific Coast will adopt one that is always ready, sure in action and a small consumer of energy. When this is done the expense of a lightning arrester system amounts to the interest on the investment entailed, and this amount is assuredly far less than the damage which might easily occur during a single storm.

Metallurgy.

TO REFINE COPPER ELECTROLYTICALLY.

The Westinghouse Electric and Manufacturing Company has shipped eight carloads of electrical apparatus to the Boston and Montana Consolidated Copper and Silver Mining Company, of Great Falls, Montana, to be used in the electrolytic refining of copper and silver. This is the largest machinery of its kind ever constructed for electrical refining purposes. Until a few years ago the copper produced in Montana was not refined there, but instead, the copper malt was sent East, or principally to England and Wales for refining; but since the introduction of electricity in the refining processes the Montana companies have been placed in a position to successfully compete with Eastern and foreign refineries.

Some time since the Anaconda Copper Company of Butte, Mont., purchased from the Westinghouse Company seven 360 horse power generators, each having an output of 3600 amperes at 75 volts, and which were direct driven by triple expansion, vertical type engines, manufactured by the Union Iron Works of San Francisco. This installation by the Anaconda company demonstrated the success of the electrical process of refining copper and it has led the Boston and Montana Company to make the installation above described.

The machinery of the Boston and Montana Company will be driven by turbines from the waters of Great Falls. The generators are to be direct connected. They are two in number and each is of 1100 horse power, having an output of 4500 amperes and 180 volts. The shipment made by the Westinghouse Company included all detailed apparatus, switchboard appliances, etc.

GREAT FALLS, MONTANA

Hydraulics

SOME TESTS OF WATER WHEELS.

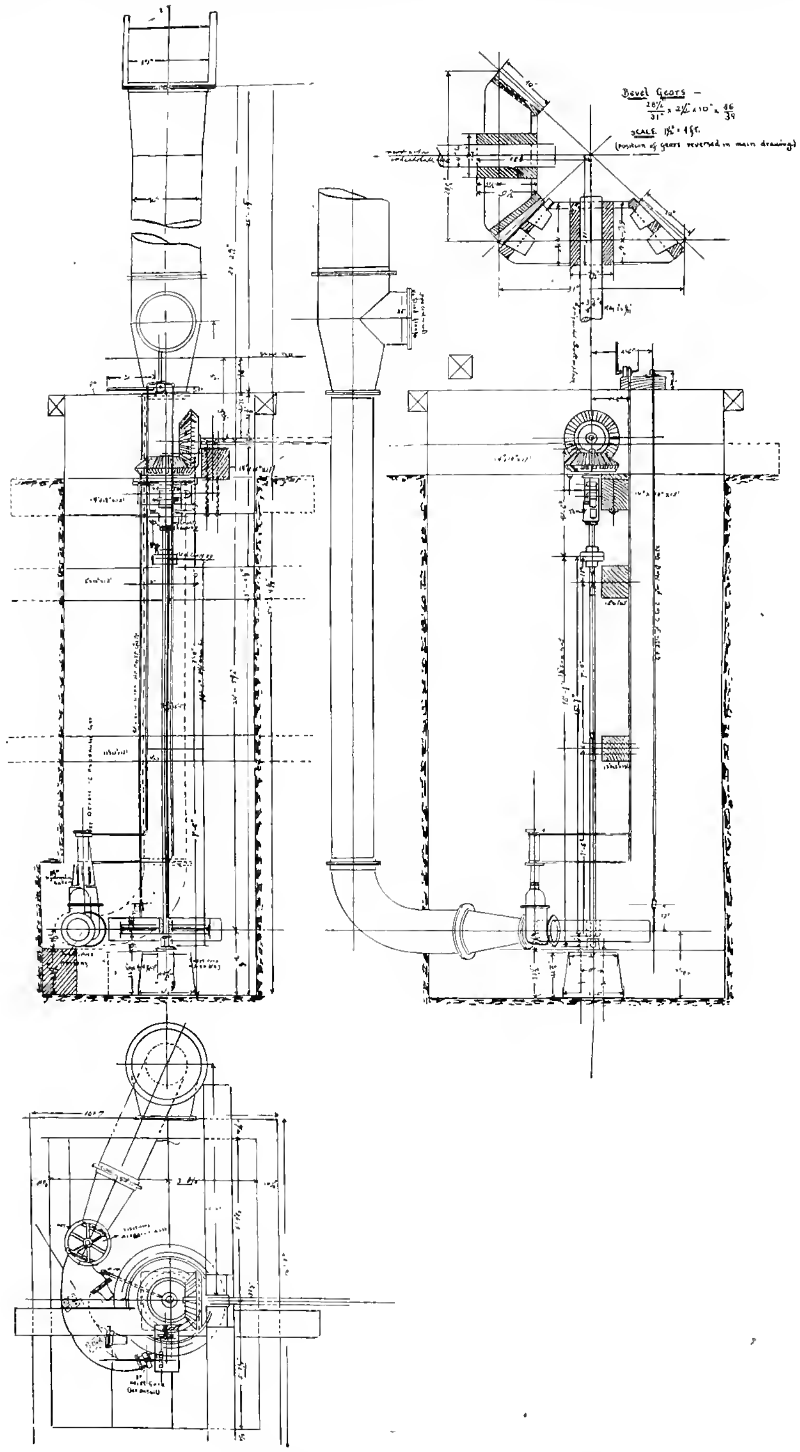
BY WILLIAM C. PEYTON

Before giving the conclusion of some measurements I have made of the water wheels in use in the mills of the California Powder Works at Santa Cruz, which are operated under the superintendence of the writer, it is well to state that the particular plant referred to, as originally installed, consisted of a turbine wheel placed in a pit 23 feet below the surface of the ground, and from which the water was discharged through a tail race consisting of a tunnel cut into the hillside from the river. We have tried various forms of turbines for rendering the duty required, which consisted in delivering power for the operation of two 15-ton Chili mills and eight Ball mills, and the belief that the efficiencies realized from the use of turbines would be materially increased by the installation of a Pelton wheel, led to the erection of the plant shown in the detail drawings presented herewith.

The California Powder Works is using upward of twenty Pelton Water wheels in the various departments of its works, but for the purposes of this article, and in order to bring out a comparison in efficiencies of tangential and turbine wheels under comparatively low heads the installation above referred to is selected. This consists of a 57-in. triple nozzle Pelton wheel coupled to the vertical shaft formerly used by the turbine, and, in fact, the novelty of the entire arrangement operating a Pelton wheel horizontally on a perpendicular shaft is due to the desire to utilize the same shafting and wheel pit as was formerly occupied by the turbine. The wheel operates under an effective head of approximately 49 feet, but this varies slightly with the head of water in the flume. It runs at 112 revolutions per minute, delivering about 25 horse-power. The shaft is $3\frac{7}{8}$ inches in diameter, and, as shown in the drawings, is 16 feet 1 inch in length to the lower face of the standard coupling. Through beveled gearing the motion is transmitted to a horizontal shaft for the purposes named.

This novel and unusual application affords an interesting example of the flexibility of the Pelton Water wheel, and the facility with which adaptation can be made to all possible requirements as well as the extraordinary results as will be shown to be obtained under such exceptional conditions under a comparatively low head. Exactly what the efficiency is I do not know, but judging from the small amount of water used its duty must be very

high. We have tried various forms of turbines in the same place, and have made a number of experiments, and the least water with which we have ever succeeded in running the mill has been 576 cubic feet per minute with a head of 51 feet 6 inches. We have found that, after a year or two of work, the turbines would take about double that quantity



of water. With the triple-nozzle Pelton wheel we have for several months been doing the same work under a 49-foot head, with a consumption of only 280 cubic feet of water per minute, thereby effecting a saving of more than half the water, with a reduction of more than 3 per cent. in head.

In addition to the wheel above described, we have lately installed a 4-foot double nozzle wheel on a horizontal shaft, driving a 6¼x10-in. three-throw pump, against a static head of 400 feet. This wheel also runs under a head of 50 feet.

At a recent measurement the Pelton wheel was found to be taking 330 cubic feet of water per minute, or a delivery of 31.25 theoretical horse-power, and the pump was delivering 225 gallons per minute or 22.8 theoretical horse-power. There was, therefore, between the water in the flume and that delivered by the pump, an efficiency of 73 per cent., which bespeaks excellent results, not only for the wheel, but for the pump.

Dr. Thos. Addison, Manager of the San Francisco Office of the General Electric Co., writes: "I desire to especially express to you my appreciation of the article in your magazine describing the transmission plant of the San Joaquin Electric Company. I consider the article admirable in every respect and the illustrations unusually fine."

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

ELECTRIC LIGHTING, Volume 1, The Generating Plant. By Francis B. Crocker, E. M., Ph. D. New York, D. Van Norstand Company, 1896. 444 pp. Price $3.00.

Up to the present time books that have been written on the subject of Electric Lighting have, with a few exceptions, been devoted to the consideration of some detail connected with an electric lighting system, such as the dynamo, the battery, the motor, the incandescent lamp or the arc lamp. Those few authors who have adopted the more ambitious title of "electrical engineering" for their works have confined themselves to descriptions of pieces of apparatus, while the principles underlying central station design and management have remained untreated, only to be learned through proctical work in engineering, through mistakes and successes. With the introduction of electrical courses into many schools, educators have found themselves faced by the problem of teaching their students to use apparatus as well as to design and manufacture it. Such use includes not merely the construction of electrical machinery, but also the problem of the location of a plant, the proper situation of the buildings, the proper choice of the steam generating machinery and the machinery for transmission, as well as to decide upon the special type of electrical apparatus to be used from that offered by many manufacturers, apparently equal in their guarantees, and where there is but little difference in price. To order machinery which depends for its excellence upon the consideration of details in its construction which are designed to facilitate its operation rather than to improve its electrical properties, is the condition which meets the engineer after he has left the school. It is rarely that the engineer has to design new types of apparatus to fit the particular conditions though his success or failure depends upon his proper choice of that which is on the market. These circumstances may possibly limit the field of the individual, though it surely tends to improve the general results obtained for the reason that the mechanical experience of those who have gone before is embodied in the apparatus at his disposal more completely than it could be hoped if each engineer was working independently and making his own designs. At the same time the similarity of the various systems and the representation of their promoters undoubtedly confuses the young engineer when making his choice of apparatus.

Professor Crocker was one of the earliest teachers of electrical engineering, and has been one of the first to feel this need. He is himself a manufacturer of motors and other electrical machinery, so cannot be charged with lack of appreciation of the knowledge necessary for designing work, but rather his recognition of the further need of electrical engineering may be taken as an additional proof of its necessity.

While more than half of this book is devoted to the consideration of the station and to the steam generating plant, the book cannot be considered as a condensation of other treatises, for the reason that new problems in station construction, steam generation and motive power are presented to the electrical engineer which are not covered by the studies upon the same subject of the mechanical or civil engineer. Since this is so, the especial character of the load upon an electrical generating plant should be the first consideration in any such treatise, for the reason that the work is valuable to the electrical engineer in proportion as discussions are devoted to his special problems. This subject of the character of the load to be applied to the generating plant and the especial needs of such a plant we do not find in its proper place as a groundwork of the whole discussion, and for this reason Professor Crocker's book seems to take too much of the character of a descriptive circular for us to consider that the final word has been said concerning the engineering problem of constructing a generating plant for electric lighting.

The cotton mill and the iron mill often use as many horse-power and as large generating units as are used by an electrical generating plant, and consequently the choice of machinery cannot be made from these considerations solely, but with the tremendously variable load curves of electrical generating plants new problems of economy are brought into the subject of steam engineering.

The necessity of an absolutely continuous supply of energy demands also consideration by the engineer, and in consequence the station must be constructed in such a manner as to facilitate repairs and to enable quick interchanges of steam as well as electric generating apparatus. These conditions determine largely, according to the station chosen, the manner of locating and connecting machinery as well as the installation of cranes and other means of rapidly handling heavy parts. Again the location of the electric generating plant on expensive ground in the heart of a city must be considered by the electrical engineer in his choice of machinery, and while the elements of choice for covering these various conditions are to be found in Professor Crocker's discussions, we think that he has missed the main point of the subject in not making them more distinctly the groundwork of his treatise.

Nowhere else that we know are the various types of prime movers, whether steam generators, gas engines, water wheels or windmills, so completely brought together and discussed upon a common standard, and the first part of the book treating of these subjects must be of great importance to every engineer as well as to the electrical engineer in particular.

The second part of the treatise which refers to the dynamo machine in particular has many of the same characteristics that we have noted in the discussion of prime movers, but in this latter section the subject of construction for quick handling and repairs is more carefully expressed, while the chapter upon practical management of dynamos and the accidents that may occur to them cannot be too carefully studied, as we might expect from previous knowledge of the little book Professor Crocker has already issued in connection with Dr. Schuyler S. Wheeler on the "Management and Diseases of Dynamos."

In the discussion of the accumulator Professor Crocker has been compelled to consider the load curve of the station as well as to describe the various types of accumulators, though it is hard to see why the load curve should be considered in the efficiency of a generating station using accumulators when it is not also considered in the choice of all other apparatus employed.

Switches, switch-boards, measuring instruments and lightning arresters finally complete the treatise, and, while as before the descriptions are reasonably complete, we must again criticise the treatment in not

making the point of the discussion the economical employment of apparatus.

Professor Crocker has done well in gathering into one book the treatment of all the details in an electric generating plant, and his work will be of value to the student as well as to the engineer, familiarizing both with the various types of apparatus at their command, though it still remains for an author to treat the subject of the generating plant as a practical and economical means of delivering energy to the distributing system.

Our engineers need more and more to be familiarized with the many classes of machinery at their command, and this book will do much in that direction; the work is performed by a competent hand and in a thoroughly impartial manner, so that its perusal will be of much benefit to all practical engineers, serving the purpose of consolidating very scattered information.

A PRACTICAL HANDBOOK ON THE CARE AND MANAGEMENT OF GAS ENGINES. By G. Lieckfeld, C. E. Translated by G. Richmond, M. E. New York, Spon & Chamberlain, 1896. 103 pp. Price $1.

This little handbook contains a series of chapters upon the choice, care and management of gas and oil engines, which are evidently written by a practical man for those who require to install and use such engines. Nothing of theoretical matter is contained within the book, and no subjects are treated beyond the necessary mechanical points to be considered in such work. This book is not written by a special pleader for this type of motor, nor is there anything within its pages which would lead to the inference that a special style of engine was preferred, and the instructions contained will apply as well to the installation and care of the small gasoline engine as to the gas engine, which is particularly treated. No attempt is made to show that the engines are capable of more work than can be reasonably expected from them, nor is there any effort made to disguise the fact that their operation is attended with the dangers necessarily incident to the employment of an explosive mixture within an engine cylinder. On the contrary, one can obtain from the perusal of its pages a fair estimate of the expense of running such a machine, and the mechanic who would carefully study the book cannot fail to learn a great deal that will increase the efficiency of the plant in his charge. So far from anything which looks like special pleading one is compelled to acknowledge after reading this little handbook carefully that the expense of gas engine operation, installation and management are apt to be in excess of those which are commonly reported by the engine manufacturers. It is carefully stated that the engines must not be installed without regard to proper foundations, allowing for the collection of flying oil, and that we must be far more careful in the selection of oil and other supplies to be used in connection with any such motor than might be necessary with any similar steam engine or electric motor. Particularly one is cautioned against relying too implicitly upon the statements of manufacturers in furnishing such engines, as we must against relying upon the reports of performances which have been achieved by similar engines, as well as against the continuous running of motors at their full-rated power.

One would judge from this that it is the custom amongst gas-engine manufacturers either to over-rate the proper power of their engines or to build parts lighter than will be necessary to stand a continuous series of explosions. Here we are compelled to acknowledge that such motors are at a decided disadvantage when compared with steam engines or electric motors, and that the advantage of the gas-engine type of motor lies rather in its cheapness of operation under special conditions than its general availability for use as a motor.

The chapter on oil engines has been added by the translator, and is so far limited in space as to leave out the consideration of gasoline motors, though the intelligent engineer can readily supply such a deficiency; at the same time it is to be hoped that this section may at some future time be extended to include the special points which must be considered in the operation of these machines.

On the whole, the practical character of the instructions given in the book are to be commended, and it is to be hoped that the publication will not be neglected by mechanics who can surely gain much from its perusal.

Financial.

POLITICS AND ELECTRICAL DEVELOPMENT.

It was with a view of ascertaining and reflecting the views of those most directly concerned in promoting electrical enterprises on the Pacific Coast, that the Journal of Electricity addressed circular letters to such parties to the effect that evidences are at hand which seem to indicate that a determination of the political issues of the present compaign will exercise a potent influence upon electrical industries. The letter referred to pointed out the fear held in some quarters that the institution of a bimetallic basis might depreciate corporate values to such an extent as to seriously interfere with the development and normal growth of electrical installation. The desire to present the opinions of those best qualified to judge, therefore, prompted the request that the parties referred to, favor the Journal with their judgment of the situation, and in response thereto the following replies have been received. Out of respect to the wishes of the writers, in some instances their names have been withheld, but the conclusion is emphatic from these letters that from the standpoint of the promotor of electrical enterprises, the support of a gold basis is believed to afford the true salvation.

A prominent San Franciscan who is President of large corporate interests, among which is an electrical transmission plant, pointedly asks: "How can any thinking person fail to conclude that if the rabble, which at the Democratic convention rushed Democracy out and Bryan in, once gets control of this government, they will rush out everything that conflicts with their communistic ideas and bring about a greater pandemonium than the world has ever seen, and the normal, or any other kind of development and growth of electrical installation will, with everything else in the way of business, be brought absolutely to a standstill."

Another San Franciscan, who is prominent in electric railway circles states that: "Should such a misfortune occur as that this State or country should elect to go upon a silver basis, the result would be to depreciate corporate and also private property values to such an extent as would effectually prevent for a considerable time the inauguration of electrical enterprises."

Mr. Carroll N. Beal, Secretary and Treasurer of the Power Development Company, which is now installing the Bakersfield Transmission, expresses the opinion that: "Should the free silver idea prevail it will, in my opinion,

check the expansion of all industries, particularly those that must be financial, which includes the large majority of the power transmission, street railway and lighting enterprises, using or proposing to use electricity. Under such circumstances capital will not seek investments except under conditions that conservative borrowers will not agree to. The result is—stagnation."

More emphatic still is the opinion of one who, almost since the birth of the electrical industry, has pursued an aggressive campaign in behalf of electrical enterprises in the Pacific Northwest, and who writes: "Business in this section has been demoralized from the date of Mr. Bryan's nomination on the Demo-Populist platform. Myself and others, from the time of the promulgation of this monstrous platform, expected business would be somewhat affected thereby, but the results have been more far-reaching than our worst anticipations, and seem to be getting worse every day. Business in electrical lines in this section is simply paralyzed. Several large power transmission schemes which were all under way and which were to be put through this summer and fall have now been shelved until after the election, which means until next season at the very earliest, and if the Bryan platform prevails, I fear that these new enterprises which are so essential to the development of this country will have to be put off indefinitely. The free coinage advocates in this section are principally mine owners and others interested in silver properties, the members of the Populist party, and the rag-tag and bob-tail elements of all the parties who think that now is an opportunity to get something without working for it.

"The mass of the business men in this section of the country are bimetallists, who believe, as I do, that the success of the present Bryan free coinage platform means a silver monometallism which will render the much desired bimetallism impossible. My affiliations have always been with the Democratic party, but myself and a large number of heretofore free silver advocates feel that, aside from the free silver section, the Bryan platform contains principles which no man with a sense of honor and a love of liberty and the integrity of his country can support, and that the issue to-day is really the good government we have heretofore had, or no government at all."

Dr. Thos. Addison, Pacific Coast Manager for the General Electric Co., writes: "It is not bimetallism that is proposed, but silver monometallism by the Democratic party, and in addition to endeavor by legislative action to nearly double the present market price of silver. This, in my opinion, would be very disastrous to all industries, and would be especially hard upon the poor man, for the reason that the cost of supplies which he purchased would be largely increased, and his salary would not be correspondingly increased.

"I think the result also would be to interfere with any extensive use of money in the development of new enterprises, and especially electric installations. I believe the gold standard is the only reasonable standard and the one which would bring greater prosperity to all of our industries."

Mr. Jno. Martin, Pacific Coast Agent for the Stanley Elec. and Mfg. Co., and whose influences are becoming pronounced in the sphere of electrical transmission, submits the following thread of reasoning: "With our currency of to-day, either paper or silver has the same purchasing power as gold, for reasons thoroughly understood. Should the free and unlimited coinage of silver at the present legal ratio of 16 to 1, without waiting for the aid or consent of any other nation, and that it shall be equal with gold for all debts, public and private (Democratic platform) be adopted, it might possibly lead to the fictitious appreciation in values for a very limited time, resulting in great evil to our industrial and material welfare.

"Two underlying principles should not be overlooked in the consideration of this question, as their effects will be positive. First, all values are regulated by supply and demand. Second, it always proves disastrous when men can receive something for nothing. Analyzing the first proposition, the cause for a decline in the value of silver, was an over-production. This condition always results in a decline in price. The second principle is clearly in opposition to the free and unlimited coinage of silver at 16 to 1 when the present ratio of value with gold approximates 30 to 1. A plethora of money results in its decreased value, and it will therefore be impossible to increase values intrinsically by the adoption of the silver platform. Capital in its ideal form is timid and never fights; when in danger it locks itself securely from mercantile and industrial demands. As a nation our great prosperity throughout the past has been accomplished in the use of capital for improvements, far in excess of our immediate ability to repay; therefore, should that capital be withdrawn, we could not hope to continue our material prosperity in advance of our normal earnings. By a restriction of improvement owing to the withdrawal of capital, all industrial enterprises would of necessity feel that declination of demand. It is conceded by all that the purchasing power of all money issued and in use in the United States is equal. The Silverites do not claim that the proposed new silver dollars will possess any increased purchasing power; in fact, they acknowledge that its purchasing power will be decreased, owing to the advance in values of all commodities.

"The prosperity of Mexico is often cited as an argument in favor of free coinage of silver. If the desideratum is to have a currency of constant fluctuation and that our laborer shall receive 40 cents per day (equivalent to 22 cents of our money) as full compensation for his services (and these are present existing conditions in Mexico), then by all means give us a free and unlimited coinage of silver; but I have confidence enough in the intelligence of the citizens of this great republic to believe that this newly developed craze will receive proper condemnation at the polls in November. I therefore conclude that 'it is better to bear the ills we have than flee to those we know not of.'"

Transmission.

ELECTRIC POWER FOR BAKERSFIELD.

The power of the Kern River, the third largest stream in California, is now about to be utilized, the work undertaken by the Power Development Company being nearly completed.

The contract for the electrical equipment has been awarded to the General Electric Company, whose three-phase apparatus will be used to transmit the power of the river to Bakersfield, a distance of fourteen miles as the bird flies.

The point selected for the power house is at the mouth of the canyon on the north side of the Kern River, almost sixteen miles northeast of Bakersfield by wagon road. Here the stream, after a boisterous course of 100 miles from the slopes of Mt. Whitney through a series of rugged precipitous canyons, forms a number of cataracts and rapids previous to taking a placid course through the cultivated valley lands. The point of diversion of the necessary flow for the power is some 9,000 feet up the canyon. Some idea of the difficulties to be overcome in this work may be gained from the facts that to secure a bed for the flume a roadway was cut from the solid rock along the sides of the canyon. All the timber was hauled by a team a distance of sixteen miles to the south side of the river. A bridge was thrown

across and a tramway 325 feet long with a grade of 30 per cent. laid up the steep hill to the point where the flume was to end. A steam sawmill was then set up at the foot of this tramway, the timber cut to proper dimensions, loaded on the cars and hauled up the grade The flume was begun at the power house end.

This flume is 8 feet wide and 6 feet deep, and is covered. A railroad track is laid upon the cover for the full length of the flume, 8,000 feet. There are no sharp angles, the changes in the course being made by curves and tangents. The grade is 5.8 to the mile, and 475,000 feet of redwood is used in the construction of the flume, which at one point is carried on an arch with 60 feet span over a bad place on the cliff. The flow is calculated at 280 cubic feet per second. At its terminus at the mouth of the canyon 8,574.9 feet from the point where it leaves the river, it is 202 feet above the power house. Here the water enters a steel pipe 540 feet long and 5 feet 6 inches in diameter. The fall from the end of the flume to the power house is 201.9 feet, and the capacity of the water is estimated at 7,500 horse-power.

The electrical equipment will consist at first of two 450 Kilowatt General Electric three-phase generators running at 257 revolutions per minute. The voltage at the dynamo terminals will be 550 volts. This will be raised in step-up transformers to 11,000 volts and will be carried on six No. 4 bare copper wires to the sub-station at Bakersfield, where it will be transformed down to 2,000 volts for distribution.

The current will be utilized at first to operate an extensive system of electric railroads connecting Bakersfield with Kern and other districts. It will also be applied at once to street and house lighting, as well as to the operation of pumps for irrigation purposes. The mines in the mountains to the East will also probably take current for their mills, hoists, pumps, etc.

The President of the company is Chas. Webb Howard. W. F. Goad is Vice-President and C. N. Beal Secretary and Treasurer. The work is being pushed to completion as rapidly as possible and it is expected that by November 1, the current will be turned into the transmission wires.

TRANSMISSION AT 22,000 VOLTS.

Projectors of electric transmission plants who have thus far found the cost of copper to form an insuperable obstacle in the building of proposed transmission plants will be interested in learning that the General Electric Company is to undertake the building of transformers for delivering current at a potential of 22,000 volts, as is shown in the contract it recently secured for the transmission of Niagara power to the city of Buffalo, for the operation of the cars of the Buffalo Railway Company. The system is to be in operation by November 4th next, and contrary to expectations, the system of transmission employed is not the two-phase, but the three-phase system, developed by the engineers of the General Electric Company, the advantage in favor of the latter lying in the fact that the transmission can be effected over three wires, whereas in the two-phase, four wires must be used to convey the same amount of power. The cost of the fourth wire is saved by the use of the three-phase system.

The contracts were made between the Cataract Construction Company supplying the electricity, and the General Electric Company, and between the latter company and the Buffalo Power & Conduit Company controlling the supply and distribution of the Niagara power in Buffalo, and the Buffalo Railway Company. The contracts provide for all the apparatus and machinery necessary for the transformation of, transmission, transformation down, conversion and delivery of one thousand horse-power to the overhead wires of the Buffalo Street Railway system.

The contract with the Cataract Construction Company covers three of the air blast type transformers. These will be the largest transformers ever constructed, and will step-up the Niagara 2200 volt two-phase current to either 11,000 or 22,000 volts three-phase. Any two of the transformers together will deliver 2,500 horse-power; the third is a spare one. It is the intention of the Cataract Construction Company to commence transmission operations at 11,000 volts, and later to increase the capacity of their transmission system by increasing the potential to 22,000 volts. The transformers will be designed and insulated to withstand the latter pressure. A complete system of air blast apparatus is also to be provided for cooling these transformers, as well as a marble switchboard with all necessary instruments for controlling their operation.

The pole line will be erected by the White-Crosby Co., and will have capacity sufficient to transmit 40,000 horse-power. This line will run from the transformer house at Niagara Falls along the two-mile line road near the track of the New York Central and Erie Railroads, will cross the creek at Division Street, and from Tonawanda to the Buffalo city line will follow the canal banks.

For transforming the power down and converting it into that suitable for street railway purposes, the Power & Conduit Co. will purchase four static transformers of about 350 horse-power each, and two 500 horse-power rotary converters. The transformers will reduce from the line potential of either 11,000 or 22,000 volts to 400 volts, at which voltage the three-phase current will be turned into the rotary converters, and then converted into direct railway current of 550 volts. These transformers and converters will be set up in the Niagara Street power station. The latter will be compound wound, and will operate in multiple with the steam-driven generators supplying the balance of the power necessary for the operation of the railway system. They will be of the iron-clad type with steel frames, with collector rings for the three-phase current at one end, and a commutator for the direct current at the other. They will have six poles and will run at 500 revolutions per minute, and are similar to that placed in the Niagara power house to furnish current to the Buffalo & Niagara Falls railroad. Work will be begun at once and current will be transmitted from Niagara to Buffalo before winter sets in.

The Trade.

ELECTRIC LOCOMOTIVES.

The first electric locomotive of any considerable size built in this country and the first practical electrical locomotive in the world, exhibited by the General Electric Company, at the Chicago Exposition, 1893, having a rated draw-bar-pull of 7000 pounds, has been purchased by the Manufacturers Street Railway Company of New Haven, Conn. It is equipped with air brake, and is being prepared for shipment from the Schenectady works within a very few weeks. Its total weight is thirty tons, and it will be utilized to haul freight cars from the junction of the New York and New Haven Railway at Cedar Hill, which is about one mile from the New Haven passenger depot, to the works of the Bigelow Company, manufacturers of boilers; the National Pipe Bending Company, the Quinnipiac Brewing Com-

pany, the New Haven Rolling Mills and other manufacturing establishments located along the water front at some distance from the freight yards of the Consolidated Road.

The freight cars will be hauled directly into the yards of the manufacturers, and the loads will be collected by the electric locomotive and hauled to the main line of the N. Y., N. H. & H. R. R., where they will be taken up by the steam locomotive for transportation to their destination. The length of the line along which this locomotive will run is nearly two miles, the maximum grade against the load being about $2\frac{1}{2}$ per cent. The guaranteed speed of this locomotive grade will be seven miles an hour, with a heavy load behind it, but judging by its performance at the Lynn works of the General Electric Company it will probably be able to largely exceed the guarantee.

All the locomotives, which the General Electric Company have built will be, when this one is delivered at New Haven, in service. The 40-ton locomotive is used as a switch engine at the Taftville Cotton Mills at Taftville, while the three 96-ton locomotives are engaged in hauling the freight trains through the Belt Line tunnel of the B. & O. Railroad; indeed, no freight train is hauled through the Belt Line tunnel of Baltimore except by the electric locomotives.

The matter of electric traction on the steam roads since the successful operation of the elevated roads in Chicago, the branch lines of the N. Y. N. H. & H. R. R. and the B. & O. main line with apparatus developed by the engineers at the Schenectady works has elicited the interest of steam railroads all over the world, and that we are on the eve of a great change in traction methods can no longer be doubted.

HELIOS ENCLOSED ARC LAMPS.

The new Helios 150-hour arc lamps which have just been received by the California Electrical Works are adjusted at the factory before shipment for 110-volt circuits, when not otherwise specified, and it will be found unnecessary to alter this adjustment. The lamps are burned singly across direct current constant potential circuits. The carbon which is used for this lamp is a solid half-inch carbon of special make. It is absolutely necessary to use these, as other carbons will not burn in the lamp.

To trim the lamp, it is first necessary to see that the cylinder is cleaned thoroughly. For this purpose and for trimming, it is taken out of the lamp, and when trimmed, returned. For the purpose of cleaning, a dry brush, such as is commonly used in cleaning globes, will be found convenient.

It is not necessary to take the cylinder from its holder for any other purpose than that of replacing a broken cylinder, and then sufficient care must be exercised to secure an air tight joint at the bottom. The carbon which is placed into the cylinder should be $5\frac{1}{2}$ inches long, and should be well centered so as to secure an even burning of the carbons. After the cylinder is cleaned and a carbon is put in, the aluminum cap is put on and it is ready for the lamp.

The lamp is trimmed in the following manner: Insert the positive carbon by pushing it through the hole in the bottom of the frame and through the hole in the guide plate. Be careful to fasten the carbon tightly in the holder, as the lamp will be short-circuited should the carbon drop out. Next push the positive carbon up into the lamp so that the bottom of the carbon rests on the guide plate; then insert the cylinder (with the cap on) by lifting the guide plate and allowing the cylinder holder to drop into the hole in the bottom frame. Lower the guide plate and allow the positive carbon to drop through it and into the cylinder. Adjust the outer globe and the lamp is ready to burn.

When the lamp is first hung, the guide plate should be so adjusted as to just clear the top of the cap without resting on it. This is done by raising or lowering the nuts inside of the lamp.

The carbon which is left over from the positive after burning will be found sufficient to serve as a negative in the next trimming. A lamp which is burning for the first time will generally be slightly unsteady for a short time. This is due to moisture which has accumulated in the globe and lamp. It may be said in general that moisture in the cylinder should always be avoided, and the carbons should be thoroughly dry when put into the lamp.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

Some public thoroughfares are created great, like Market street, others are made great by street car lines, like Larkin, Mission, Devisadero and other young and growing business streets. Others have greatness thrust upon them. It is unsafe, however, for a street to wait for greatness. A combination between the property-owners and a street car line, as in the case of Mission street, will produce results far more speedily. The way to make a great street is to induce people to walk along it and transact business. How can this be done more effectually than by laying a smooth pavement and building a good car line? —San Francisco Post.

Interior portions of Sonoma county, as the other interior portions of our state are taxed in the form of railroad tariff, "all the traffic will bear." We hail with delight the suggestion to build electric roads in many portions of our county. If the promoters will see to it that they can carry freight as well as passengers as far as tide-water, it will be great boon to farmers. In fact all our business men as well as farmers could afford to give a good bonus to secure such competition. Electric roads owing to cheap building and operating expenses might be of untold benefit to this county.—Santa Rosa (Cal.) Farmer.

As the transmission of electric power for long distances is becoming more and more a demonstrated fact, a change in the motive power of the country is becoming an acknowledged certainty, and is attracting the attention of engineers and manufacturers throughout the country. A few days ago Eastern members of the American Association of Civil Engineers, who have been making a tour of the coast, paid a visit to the great dam on the American River near Folsom, and the Sacramento Electric Light and Power Company's mammoth long-distance transmission plant. On their return to Sacramento they expressed their astonishment at what they saw at Folsom. The big dam, they declared was a magnificent piece of engineering skill, and the electric plant, which sends its thousands of horse power twenty miles to the city—the greatest enterprise of the kind in the country.

It is only a question of time when the streams flowing from the Sierras will be utilized for the generating of electricity, furnishing power for not only manufacturing enterprises, but also for running thousands of quartz mills, thus settling the question of the cheap extraction of the precious metal from the ores of the thousands of rich leads only waiting for this wonderful power to be developed and utilized to make it profitable to the miner to open up these treasures hidden in the rock-ribbed mountains and foot hills of this State. Electricity will not only furnish the motive power for the running of quartz mills and hoisting works, more, the time is coming, and not far distant, when rebellious

ores will be cheaply and successfully treated with this wonderful agent, electricity, increasing the gold production of the State by millions. Here is a profitable field for the capitalist, who, while rendering great service to the State, can put money in his purse, by erecting electric plants throughout the mining sections of the State.

Another advantage—the use of electricity generated by water power, will preserve the timber sections, now being denuded to furnish fuel for steam power for the running of mining machinery and mills. The success of the enterprise is demonstrated at Folsom—let the number be increased indefinitely. The Amador canal could furnish power for a large section of mining country. The same amount of water required to run a twenty stamp mill with water power, would generate electric power sufficient to run a hundred stamps. We suggest that the Amador Canal Company investigate this subject—there is a great field open to that corporation.—Oakland (Cal.) Tribune.

Personal

Mr. Chas. C. Moore, Pacific Coast representative of a number of select steam specialties, is East on a business trip.

Dr. F. A. C. Perrine, Professor of the Department of Electrical Engineering of the Leland Stanford Jr., University, has been summering at Lake Tahoe.

Mr. C. H. Plunkett of the Sprague Electric Elevator Co., has returned to New York after having completed the Sprague elevator installation in the Parrott and Safe Deposit buildings, San Francisco.

Prof. C. L. Cory of the Electrical Engineering Department of the University of California, has been spending the summer vacation in examining the various transmission plants and projects in Central California.

Mr. Theodore E. Theberath of the electrical engineering staff of the Stanley Electric Manufacturing Co., has been assigned the electrical engineership of the Pacific Coast office of that concern at 106 Market street, San Francisco.

Mr. Mark A. Replogle, chief engineer of the Replogle Governor Works of Akron, Ohio, is in Oregon City, Oregon, where he has been installing Replogle governors on the turbines of Station B of the Portland General Electric Company.

Mr. Edgar E. Stark, constructing engineer for the Stanley Electric Manufacturing Co., leaves for Bonita, Mont., on August 30th, to superintend the installation of a large Stanley power transmission plant. Mr. Stark has been on the Pacific Coast a little over a year and has made hosts of friends in every branch of the electrical industry who hope for his early return.

Reports of the Month.

INCORPORATION

The Alaska Electric Light & Power Co., of Juneau, Alaska. Capital Stock, $100,000. Organizers: Robert Duncan Jr., J. P. Corliss, A. W. Corbur and J. F. Malcolm. This company is formed under the Oregon statue made applicable to the District of Alaska.

Los Angeles, Cal.—The Water, Electric & Power Company of Los Angeles; capital stock, $3,000,000. Objects: to acquire and develop water rights and to generate and transmit electricity. Directors, C. E. Brooks, W. H. Shinn, W. W. Everett, G. W. Bentley, A. W. Bagley, A. A. Stoiber and L. Friel.

San Francisco, Cal.—The San Francisco and San Mateo Railway Company has been reorganized and incorporated with the following Board of Directors: A. B. Spreckels, president; John A. Buck, vice-president and general manager; Walter D. K. Gibson, treasurer; D. Clayton, secretary; directors—J. D. Spreckels, Nicholas Ohlandt. Capital Stock, $1,000,000 in $100 shares and 501 shares being subscribed as follows: J. D. Spreckels, A. B. Spreckels, John A. Buck and Nicholas Ohlandt 125 shares each and Walter D. K. Gibson 1 share.

TRANSMISSION.

Sutter Creek, Cal.—Knight & Co. are building the water wheels for the Pioneer Electric Power Company, of Ogden, Utah.

Nevada City, Cal.—Definite plans have not been agreed upon as yet regarding the electric and water power plant for the Allison ranch mine.

Coulterville, Cal.—Two electric power schemes are projected for this location, one by H. H. Clark, utilizing water from the Merced river, and the other by Captain H. H. Ward, utilizing the power of Broadhead dam.

Livermore, Cal.—The Livermore Water and Power Company is soon to be incorporated for the purpose of developing the Mocho water proposition, furnishing water and power for operating an electric plant for Livermore.

Redding, Cal.—Dr. W. H. Garlick, owner of the Calumet mill and mine, will establish an electric power station of 300 h.p. for operating the quartz mills in Old Diggins and the Hart mine, which alone has contracted for 100 h.p. Almarine B. Paul is Dr. Garlick's agent.

St. Helena, Cal.—It is rumored that the Edge Hill property has been sold by Ernest Dichman, of New York, to an electric company in that city, and that it is proposed to put in a water storage system from which sufficient power can be generated to operate an electric railroad and light plant from San Franseisco Bay to Calistoga. J. M. Graham has made a careful investigation of the water in the mountains back of Edge Hill and says that the place affords the construction of one of the finest storage systems he has ever seen.

LITIGATION.

San Francisco, Cal.—It is reported that the Western Electric Company of Chicago, constituting the manufacturing branch of the American Bell Telephone Company, has instituted suits against the Standard Telephone Company in the United States Circuit Court for the western district of Wisconsin, on the infringement of patents numbered 256,258, 309,617, 303,714, 299,926, 27,522, 28,266, said to cover telephone connections, bell apparatus, switchboard appliances and general office mechanism, upon all of which the American Bell Telephone Company holds unexpired patents. The Standard Telephone Company is operating exchanges in Portland, Sacramento and San Jose which are vitally interested. These suits are said to be independent of the Berliner case, covering the basis patent of the transmitter, now pending in the United States Supreme Court.

Los Angeles, Cal.—Judge Wellburn of the United States Circuit Court has overruled the demurrer of the defendant in the cause of the Western Union Telegraph Company vs. the Los Angeles Electric Company. An essential fact of the complainants case was that the wires of the defendant corporation had been placed so near to the wires of the complainant as to seriously impair the efficiency of the latter by induction, and the Court in passing upon the contention of the defendant, that an electric company carrying on the business of street lighting has paramount right of occupancy held that the wires may be so adjusted that both companies can use the same side of the street without electrical interferance and that the question which of the companies must make this adjustment of its wires depends upon the question of which company was prior in its occupancy of the streets with its wires.

TRANSPORTATION.

Nevada City, Cal.—A 150 kw. Stanley induction motor now operates the Gold Hill Mine.

Santa Ana, Cal.—E. I. Tolle has been granted a franchise for an electric road along main street.

Santa Monica, Cal.—The Pasadena and Pacific Electric Railway Co., has completed its extension to the southern portion of the city.

Phoenix, Ariz.—D. A. Abrams has applied for an electric railway franchise, agreeing to commence work within six months and to spend $100,000 on the road.

Everett, Wash.—The electric railway system is being extended to Hotel Monte Cristo and to the paper mill and nail works wharf, involving about 2,000 feet of track.

Seattle, Wash.—The Boston & Seattle Company is installing an electric power plant for its mines in the Miller Creek district.

Angels, Cal.—Lewis J. Hutchinson is working up a power transmission plant.

Other motors will be placed in various shops as fast as they can be secured, until all the shops are supplied. It is calculated that a large saving in cost of operating machinery will be made by the introduction of electricity.

City of Mexico, Cal.—H. S. Jacobs is endeavoring to secure control of the water power available at a point three miles below the junction of the Amacusac and Baranquillo rivers, presumably for electric transmission purposes.

Tucson, Ariz. Otho Moses is authority for the statement that the Ripsey Mine, 65 miles north of here, will install an electric transmission plant operated by water power shortly. The mine is owned by the Norman Mining and Milling Company of San Francisco.

Santa Barbara, Cal.—The Santa Barbara Consolidated Electric Railway Company commenced the active construction of its system on June 22nd. All of the iron and ties are on the ground

Seattle, Wash.—The Ranier Avenue Electric line is extending its system to Renton.

Fresno, Cal.—After two months' delay the 180 horse-power General Electric Induction motor for the Sperry Flour Mill in this city has arrived and is now being erected. It will be operated from the three-phase transmission circuit of the San Joaquin Electric Company.

Newcastle, Cal.—The Central California Electric Company has awarded the contract for two pairs of 48-inch Pelton wheels to operate the Westinghouse generators for its transmission circuit to Sacramento, 28 miles distant. The wheels will run at 400 r. p. m. under a 420-foot head.

Oakland, Cal.—The Oakland Consolidated Street Railway Co.. is equipping its cars with a substitute for fenders consisting of two strong iron rods bolted securely to the front of the car in a position to enable them to be easily grasped by the person who is in danger of being run over.

Phoenix, Ariz.—The Co-Operative Mining and Milling Company, is operating an electric plant on the Agua Fria river, five miles east of Bumble Bee, consisting of a 50 h. p. Westinghouse dynamo, driven by a Pelton wheel, running under a 202 foot head. It is probable that the plant will be largely extended after the election.

Riverside, Cal.—The City Trustees have fixed the rates for electric power from the municipal plant at $4.00 per horse power per month for the first and $3.00 per horse power per month for each subsequent horse power. The power is sold to the city by the Redlands Electric Light & Power Company at $3.00 per horse power per month.

Toluca, Mex.—The Toluca Electric Light and Power Company, owned by Messrs. Henkel Bros., has been inaugurated by Governor Villada, of the State of Mexico. Westinghouse apparatus is used throughout and the plant was installed under the engineership of J. A. Sternefeld, manager for G. & O. Brannish & Co., of the City of Mexico.

Stockton, Cal.—The electric railway system in this city is now operated from a 100 kw. multipolar General Electric generator driven by a 125 horse power, Otto gas engine consuming natural gas. In delivering 122 horse power the engine used about 2,000 feet of gas per hour. Heretofore the company has been burning natural gas under its boilers.

Sacramento, Cal.—The first electric motor operated by power transmitted from Folsom, used in the Southern Pacific Railroad shops, has been placed in the spring shop. This is to be followed by a 10 h. p. motor in the tube shop, a 50 h. p. motor in the boiler shop. a 50 h. p. motor in the foundry and a 10 h. p. railway motor is to be placed on the transfer table.

Spokane, Wash.—B. C. Riblet and Major Chapmen of this city have located a water right at the falls in the Pend d'Oreille river a few hundred yards above its confluence with the Columbia, and has made all surveys and estimates for a water power and electric transmission plant to supply electric power for operating the mining interests in and about Rossland and Trail, B. C.

San Francisco, Cal.—The Commercial Steam Power Company at present supplying steam power to the many printing offices in the printing district, is erecting a 150 kw. Stanley generator, to be used for power transmission purposes in the displacement of the extensive system of shafting and belting that is now carried underground through the several blocks of the district.

Monterey, Cal.—The Monterey Power Company has resumed work on its flume and pole line near the Little Sur river after nine months of litigation over land rights and privileges. The electric power generated will be transmitted 23 miles to Monterey and Pacific Grove, where it will operate the electric light street railway systems.

Redlands, Cal.—A. H. Smiley has ordered a preliminary survey for the proposed electric railway to Fredalda Park. This will be a mountain railway and Engineer McPherson who built the Mt. Lowe Railway is now at work on the survey. A portion of the power for this road will be obtained from the canyon along the route and the balance will be taken from the Redlands plant.

Coulterville, Cal.—G. F. Allardt, C. E.., and M. E., and party are at work on the survey for the Mariposa Electric Power Company, and the party is at present located at Camp Mariposa which is also the headquarters of Chas. T. Lindner, the promoter of the enterprise. The company is to be incorporated shortly, and it is proposed to provide for the installation of 4,000 horse power. If necessary about 7,000 horse power can be readily developed.

Ogden, Utah.—The contract for the power house of the Pioneer Electric Power Company has been awarded to William Fisher for $19,097. And the contract for the electrical equipment has been awarded to the General Electric Company. The transmission circuit will extend from the mouth of Ogden Canyon to this city, and thence to Salt Lake City, 38 miles distant. The line will be completed in about four months, and the original installation provides for delivery of 5000 horse-power in Salt Lake City. The entire plant involves an outlay of $1,250,000 and 20,000 h. p. of water power is available.

Azusa, Cal.—E. C. Seymour of San Bernardino, representing Los Angeles and San Francisco capitalists, has been prospecting the San Gabriel Canyon, and will favor the establishing of a system of reservoirs and the building of about 14 miles of pipe line which will develop about 4000 h. p. from seven Pelton wheels running under a head of 2000 feet. The survey shows that there are to be 26 tunnels and about 15,000 feet of cuts through the granite slopes to carry the 48-inch wooden pipes. For about 7 miles the water will have a fall of eight feet per mile.

and bids for the construction work will be advertised for as soon as the engineer's reports can be prepared. A. C. Balch, formerly of the Union Power Company of Portland, is promoting the enterprise, and W. G. Kerckhoff of Los Angeles is one of the interested capitalists.

San Diego, Cal.—The Citizens Traction Co., has placed its new system in operation on July 28th.......The San Diego Electric Railway Co., has applied for permission to extend its 16th street line on various streets to 25th street, thence northerly to the present terminus of the "D" street line.......The San Diego Electric Railway Company has sent a communication to the council agreeing to furnish water and sprinkle streets that its lines travers at one-half the present expense. This will necessitate the laying of a large ten-inch mains and to building a sheet steel reservoir holding 250,000 gallons.......The new plant of the Citizens Traction Company consists of two 400 horse power Corliss engines; four 100 horse power flue boilers; two 100 kw. General Electric Generators and ten double G. E. 800 equipments.......The San Diego Electric Railway Company has installed a 200 horse power General Electric multipolar generator.

City of Mexico, Mex.—J. Q. L. Lamae, Manager for General Fhisbies Tramvias at Jalapa, reports that half of the grading is completed and that track laying will soon be actively prosecuted. This will be the first electric railway in Mexico, and should the system meet with favor, other roads will be rapidly equipped. The road will be operated by water power, there being about 5,000 horse power available. The electric power plant will cost about $100,000 and will probably be completed by Christmas.......The third payment, amounting to $825,000, on the purchase price of the district railways of the City of Mexico was made on July 6th, and on July 30th a meeting of the company was held at its offices, No. 12 Calle de Santa Clara, to perfect the dissolution of the old company and close up its accounts. Thos. H. McLean is General Manager of the new company. The trolley system is to be used, but the type of apparatus has not yet been selected.

Los Angeles, Cal.—Ordinance No. 3,649 granting an electric railway franchise to H. G. Wilshire has been revoked by the passage of Ordinance No. 3,761.......Ordinance No. 3,686 has been passed granting to the Mateo Street and Santa Fe Avenue Street Car Company permission to convert its horse car lines into a single or double track electric railway system.......W. H. Cook has secured a subsidy of $13,000, in view of which the Los Angeles Traction Co., will extend its line in the south-western portion of the city to Western Avenue.......The 800 kw. Walker generator for the Los Angeles Railway Company is being erected under the superintendence of C. H. Baker, recently of Detroit.......The Traction Company's extension from Vermont Avenue on Vine street, Rosedale Avenue and Adams street to Western Avenue is in operation.......W. H. Workman has petitioned the council to advertise for a franchise to Boyle Heights by route consisting of a number of streets which are now used by the Los Angeles Railway Co.

TABLE OF CONTENTS

Abbreviations: Illustrated (*): Editorial. (Ed.): Educational. (Educ.): Electro-Economics, (Elec-Econ.): Electro-Insurance. (Elec-Ins.): Electro-Therapeuty. (Elec-Ther.): Financial. (Fin.): Hydraulics, (Hyd.); Illumination, (Ill.); Literature. (Lit.): Metallurgy. (Met.): Mining, (Mi.): Passing Comment. (P. C.): Physics. (Phys.): Pneumatics. (Pneu.): Telegraphy. (Teleg.): Telephony. (Telep.): The Trade, (T.): Transmission. (Transm.): Transportation. (Transp.)

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The Big Cottonwood Power Transmission

Before proceeding to a description of the recently completed electric transmission of the Big Cottonwood Power Company it is well to briefly review the natural advantages of the country contiguous to Salt Lake City in order that an accurate idea of the importance and far-reaching effect of the enterprise may be appreciated. It has been pointed out in an article by Mr. Geo. Heli Guy, in the Electrical Engineer, that cheap electric power for Salt Lake City and vicinity will open up unequalled opportunities for various electrical enterprises not only in the delivery of power for the operation of existing installations, but also for electro-chemical work. The district has bauxite in abundance, and in this industry power is all-important, and freight is hardly considered. For the manufacture of salt products, bleaching powder, disinfectants, soda, sodium, calcium carbide, etc., all the raw materials are on the ground, and cheap power only is needed. The electro-deposition of copper will certainly grow into a huge industry, for the extensive leads of copper ores are as yet undeveloped. A large copper smelting plant has recently been placed in operation. The electro-deposition of gold and silver is also a coming industry which will rapidly expand when cheap current increases the economy of the process. These are classes of work depending for their successful prosecution almost entirely on power, and requiring materials mined or found in the Salt Lake country in enormous abundance. In mills and factories the ordinary industrial operations likely to be created by cheap power are wool scouring, paper making, the manufacture of cotton fabrics and the making of flour. With the increase in these factories there will be a call

RESERVOIR OF THE BIG COTTONWOOD POWER COMPANY

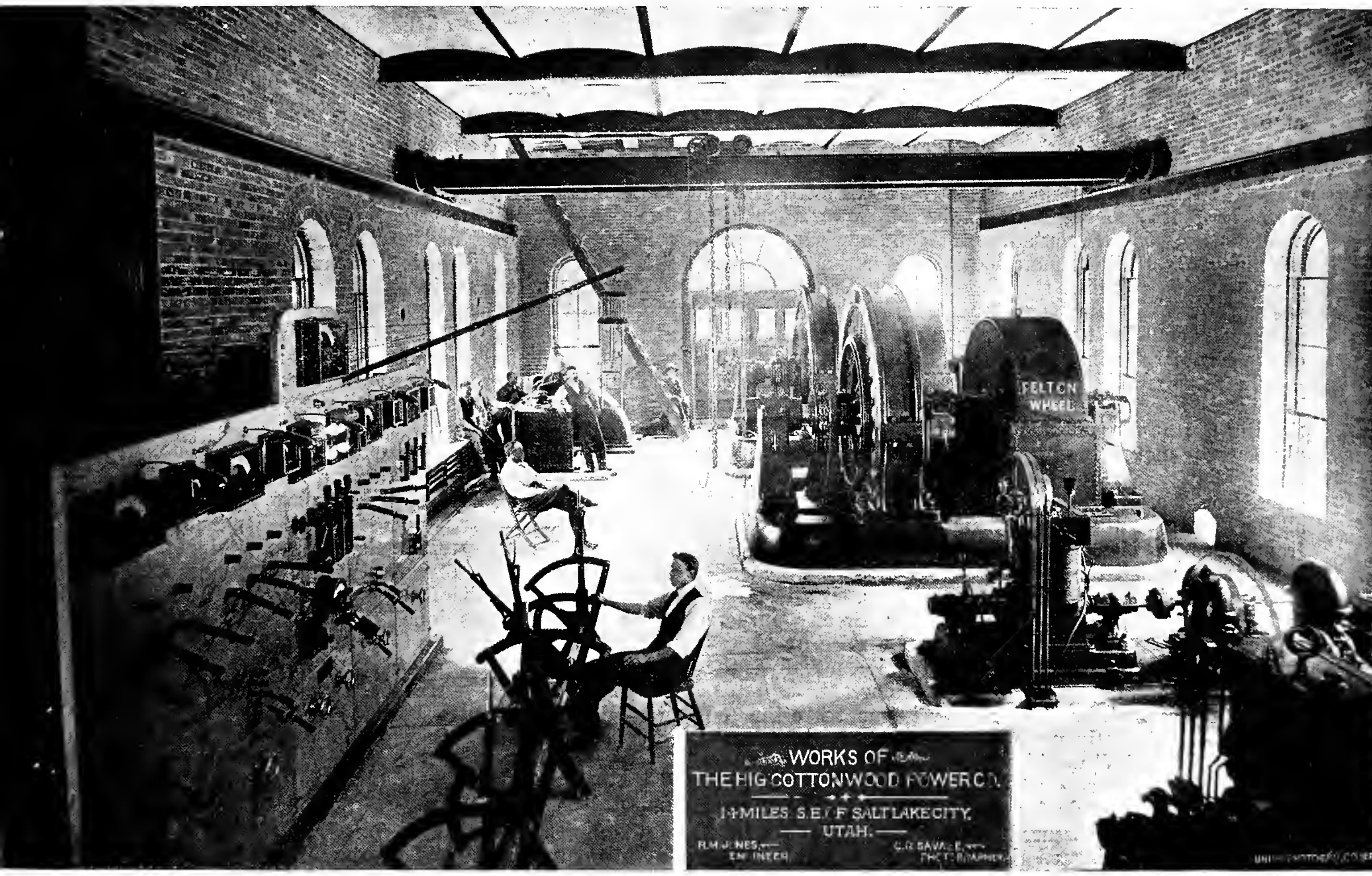
for better facilities for iron workers and engineering work, which will require further power. There will be a prompt and large demand for current for electric transit. Cheap power will enable trolley lines to be pushed out all over the Salt Lake Valley to be used for bringing farm produce into the city and ores to the smelters. With these improved facilities for transportation, the farming industry of the Salt Lake Valley will increase enormously, and a large fruit trade will be established. Three electric roads are already operating successfully: the Salt Lake City Railroad Company, the Salt Lake Rapid Transit Company and the West

POWER HOUSE OF THE BIG COTTONWOOD POWER COMPANY

Side Rapid Transit Company, operating in the aggregate upward of 100 miles of track and about 100 cars. These roads already stretch out from 5 to 10 miles from the centre of the city. The output of gold and silver ore with lead bases is infinitely larger than statistics show, owing to the fact that enormous quantities of ore are shipped to Colorado smelters. Before long these ores will be smelted in Utah by electrical processes. The headquarters of the large mines, such as the Ontario, Centennial, Eureka, Mammoth, Anchor, Crescent, Silver King and the various mines in Park City, Tieutic, Bingham and Mercur, are all located in Salt Lake City. The first successful practical application of the cyanide process for extracting gold ores was made at the Mercur mines located within 10 miles of the city. There are four large smelters and five sampling works. These smelters and the mines require large quantities of power continuously through the year, and though the application of electricity to mining is somewhat slow, it will surely become general. The Ontario mine has taken the lead by putting in a small monocyclic light and power plant, utilizing the water from the great drain tunnel.

The Big Cottonwood river forms the drainage of the Wahsatch range of the Rocky Mountains, lying immediately back of Salt Lake City, and the lakes entering into the Big Cottonwood canyon, lie at altitudes of from 11,000 to 13,000 feet above the sea, so that difference of level is considerable even when the water is made to give up its energy at a point some thirteen miles southeast of Salt Lake City. As a matter of fact, the company has available over 1,000 feet of fall in various spots, but at present is using less than 400. The power station, illustrated on page 22, is situated in the canyon at "The Stairs," about 14 miles by pole line from the distributing of "step-down" station of the Salt Lake and Ogden Gas and Electric Light Company, in Salt Lake City. At this point there is a minimum flow of 3,400 cubic feet per minute, which, working under 380 feet head, produces 2,447 horse power any and every hour in the year. During nine months of each year, it will give nearly 4,000 horse power. The frontispiece illustrates the

storage reservoir at the head of "The Stairs," which has an available capacity of 24 hours' continuous flow of the stream, making all of the water available by using an excess during maximum loads and allowing the reservoir to accumulate during minimum loads. 58,800 horse power per day of 24 hours, is looked for from this source, of which 68 per cent. can be delivered in Salt Lake City in contract form, making 40,000 horse power hours net daily. The 68 per cent. efficiency is derived from: Pelton water wheels 80 per cent., General Electric Company generators 94 per cent., G. E. transformers (raising) $97\frac{1}{2}$ per cent., line transmission 95 per cent., G. E. transformers (reducing) $97\frac{1}{2}$ per cent., or a total of $68\frac{1}{2}$ per cent. The map of the reservoir shows a pipe line extending from the head gates, submerged in the bottom of the reservoir, to a penstock or receiver wood housing with "grizzlies" located just below the bridge. This pipe, of steel-banded redwood, is anchored to the bottom by rock piles, and is to be used in the event of its being necessary to drain the reservoir, without interfering with the running of the station. This is accomplished by closing the headgate valves, and the station can thus be supplied from the natural flow of the stream, during such time as the reservoir might be empty. The steel pipe line was built by the Frazer & Chalmers Company of Chicago.



INTERIOR OF THE BIG COTTONWOOD POWER HOUSE

The outside dimensions of the generating station are 34 feet by 100 feet. The generating plant, a view of one half of which is shown on page 23, consists of four 450 kilowatt three-phase 60-cycle General Electric generators, separately excited, non-compounded, set with armatures parallel to each other, facing up in true line in the building. Each generator is driven directly by one heavy special Pelton wheel, 60 inches in diameter, provided with two nozzles of $3\frac{1}{4}$ in. diameter. The nozzles are provided with hood valves for shutting off, so that both good regulation and economical use of water are secured. Each nozzle at 370 feet effective head, produces 310 mechanical horse power, and drives the wheel at 300 revolutions per minute, its economical speed. The water wheel is keyed directly on the armature shaft, and in addition to the generators named, four $12\frac{1}{2}$ kilowatt exciters are connected together in pairs by couplings, each set being driven by a 14-inch Pelton wheel, with cast housings. Each set consists of two generators and two wheels, built up on a cast-iron base-plate, making a rigid and direct connection. This application provides exciting energy in two units, and at all times either one or two exciters are in reserve. The exciters are to be run in multiple, and all connected to one common "bus line" on the switchboard. The three-phase generators are also operated

in parallel. There are six raising transformers, 265 kilowatts each, of General Electric make.

The station switchboard consists of 5 panels with complete controlling and indicating apparatus, and there is a 3-panel raising transformer switchboard. At the step-down or distributing station, there is a 3-panel reducing switchboard, with proper regulating apparatus. The apparatus is protected by ball lighting arresters, and the transformers are cooled by two Sturtevant exhaust fans driven by two 5-horse power induction motors.

The 915 poles for the line construction were selected from live growth of Sand Point (Idaho) cedar. The smallest are 40 feet long, and 8 inches in diameter at the top. They are placed 100 feet apart. The line conductors will consist of 12 wires, four circuits of three wires each, but only three such circuits are now in position. All wires are of No. 2, soft-drawn bare copper, and connected to the same common "bus line," at the generating and at the distributing station. The line loss, in delivering 1,520 kilowatts at 10,000 volts, is something less than 5 per cent.

The transmission line from generating to distributing station is 14 miles by pole line. The distributing station is owned by the Salt Lake and Ogden Gas and Electric Light Co., who rent it to the Big Cottonwood Power Company at a nominal rent. It contains, for "step-down" transformation, nine 160 kilowatt air blast transformers, from the secondary side of which the Electric Light Company buys the current wholesale by meter. This arrangement is a most convenient one for both companies. The actual terms of the contract are that the electric light company is to be supplied with all the current it can dispose of for electric lighting and power, in units of 10 horse power, and under, the Big Cottonwood Company reserving the right to supply power to motors in units exceeding 10 horse power, and the right to reach such wholesale users of power by wires erected on the electric light company's poles, throughout all the districts within the city limits. The contract dates from January 1, 1896, and runs for a term of five years. Its conditions are that the current is bought at 2,000 volts, 3-phase, at a stipulated price per k. w. hour, which will be used to supply electric light and power for any purpose up to 10 horse power, and for elevator service up to any limit desired by the lessees. 2,000,000 units annually is the minimum limit of the consumption of current.

The final cost of the complete development is estimated at $300,000. An estimate of $300,000 for the original outlay for "The Stairs" would give for construction expenses —at 2,258 horse-power—$132.72 per net horse-power delivered in the city ready for use. The future of the company seems to be well assured. The company's affairs have been so well administered that much more than half the power to be developed has already been disposed of absolutely, and the guaranteed total revenue from completed contracts is over $100,000 annually. Although the company is confining its operations for the present to "The Stairs" supply, it has, as already stated, other valuable water rights partly developed by means of which it could at any time largely supplement its output.

In order to secure the best results from the three-phase current the Salt Lake Gas and Electric Company, originally a single-phase plant, has modified its distribution system. The new system consists of a network of primary mains with a network of low tension secondaries, wherever the houses are in close proximity to each other. The primary mains are at 2,000 volts. They run along every street east and west and have equalizing cross mains on several streets running north and south. There will eventually be ten feeding points, though at first only six are required. Secondary mains are used almost entirely; only when the houses are very scattered separate house transformers are used. In the commercial district, the secondary and primary mains will eventually be put underground, though this is not immediately contemplated. The transformers are placed at street intersections in banks either fixed on poles or in any suitable location near the intersection. In the commercial districts there will be a bank of transformers at every street intersection; but in the incidental districts one bank will be placed at every other intersection, the blocks being 792 feet square. The feeders are brought from the distributing station situated near the center of the town. The current is supplied from the generators of the Big Cottonwood Power Company's station on the three-phase system. The feeders and primary mains therefore consist of three wires each of the same size. The secondary mains consist of three wires and a neutral wire. The voltage between any one of the three wires and the neutral is 115, and this is the voltage of the lamps. Motors, synchronous or non-synchronous, can be connected at any point to the secondary mains, or, when the motor is large, separate transformers will be used. It is intended to eventually use the alternating current for all arc lamps, in which case they will be connected to the secondary mains with small transformers. At present the arc lighting of the city is done by constant current generators driven by three-phase synchronous motors in the old steam power house of the Salt Lake Gas and Electric Company.

The distributing station is a substantial fire proof building, with a room for the 10,000-volt step-down transformers, the 2,000-volt switchboard and fitted up with instruments for testing and calibrating meters, etc.

The distributing system and feeders have been designed of ample capacity for a small drop, and with the complete system of primary and secondary mains the regulation is perfect. By cutting out transformers during times of light load, it is expected to obtain a very high distribution efficiency. The Stairs plant of the company was completed in time to deliver current in Salt Lake City by June 1. A few days after, the greatest flood seen in thirty-five years rushed through the canyon, thus testing in the severest manner the strength of the construction. Not a dollar's worth of damage was done.

The officers of the Big Cottonwood Power Company are John W. Donnellan, president (cashier Commercial National Bank, Salt Lake); W. H. Rowe, vice-president, (president Bear River Canal Company); Geo. M. Cannon, secretary (cashiers, Zion's Savings Bank, Salt Lake); G. M. Downey, treasurer (president Commercial National Bank, Salt Lake); R. M. Jones, engineer and manager, Salt Lake; Jos. W. Summerhays, director, Salt Lake. The Old Colony Trust Company, of Boston, is its trustee.

At the present time, The Stairs plant, at ruling rates for current, can earn $200,000 per annum, and it would seem that a ready market exists for light and power now, some 27 concerns using over 2,000 horse-power. Many of these establishments work every day the entire year, and their steam power has cost them from $90 to $145 per horse-power per year.

These works have involved an outlay of something over $300,000, all of which has been furnished by local capitalists. The company states that contracts for power have already been made, which afford a revenue of $100,000 per year with a very considerable surplus of power yet to be disposed of, which insures a dividend of not less than 20 per cent. per annum over and above interest and operating expenses.

The financial as well as engineering success that has attended most enterprises of this character in various parts of the country, has given assurance of safe and profitable returns to all such investments where planned with proper reference to cost of installation and commercial value of power produced.

Telegraphy

IMPROVEMENT IN DYNAMO-TELEGRAPHY.

BY F. P. MEDINA.

The substitution of dynamo generators for chemical batteries in Telegraphy, while on the whole a great improvement, was attended by impairment of the efficiency of quadruplex systems. It augmented very considerably a cause of vagueness in signaling that the researches of many experimenters had gradually minimized. It involved the return to a method of signaling with double currents, that existed before Edison introduced his continuity-preserving pole-changer, and lost to the dynamo-quad some of the fruits of the great inventor's best work on the chemical-quad.

In spite of these facts, the superiority of the dynamo as a generator induced the Pacific Postal Telegraph Company to install a plant in its San Francisco office. Mr. L. W. Storror, the superintendent of the company, would not permit the existence of one defect in a single piece of apparatus to stand in the way of the adoption of an improvement so great in every other particular: and especially as he did not believe the defect was irreparable. Besides, the dynamo-quad had been worked in the East, and if it could be worked in one place it certainly could be worked in another. He therefore directed its adoption and in 1894 San Francisco office was equipped with the new generators.

Two direct current transformers were used, one to give E. M. F. of position sign, the other of negative. They transformed from 110 volts to 400, and were manufactured by The Electrical Engineering Company of San Francisco. The character of the motor generator combination used is clearly shown in the accompanying illustration and the distinctive feature of the dynamo appearing at the left in Figure 1 is the large diameter of its commutator and the arrangement of the eight brushes which are placed equidistant on the surface of the commutator, thus affording different potentials from which have been operated successfully for the past four years, telegraph circuits of various lengths from a few hundred yards to 1,200 miles. In this respect he dynamo telegraph plant of the Pacific Postal Company differs from similar installations in the East, where a separate machine is used for each potential.

The quads worked very inefficiently and the technical department felt obliged to continue the use of the chemical batteries on them. Reports of the dynamo-quads in the East were conflicting, and not on the whole very encouraging. Mr. Storror promoted experiment, however, and it is chiefly due to his persistence and never-failing confidence as to ultimate success, that the dynamo quadruplex is now being worked by the Pacific Postal Company with even greater efficiency than was attained with chemical batteries. The improvement has been accomplished by a device, the nature of which will be better understood after comparing the dynamo-quad with its chemical progenitor.

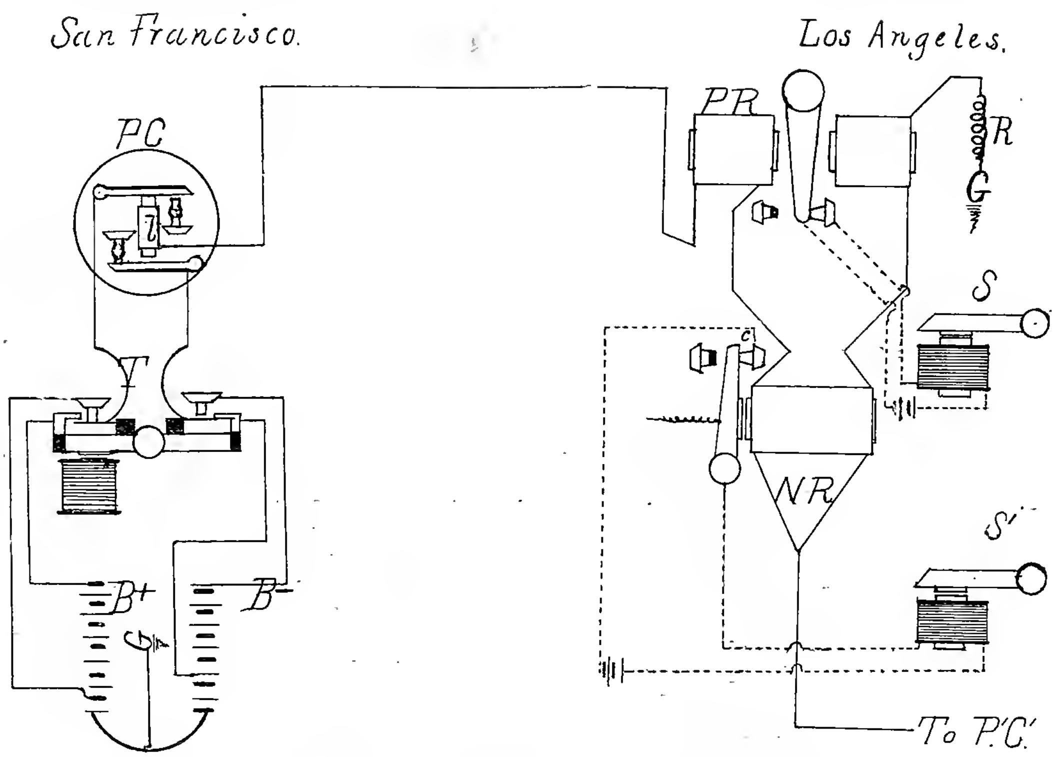


FIG. 2—SIMPLIFIED DIAGRAM OF A QUADRUPLEX CIRCUIT.

On long circuits the cause of vagueness in signaling becomes, even in chemical quads, exceedingly marked and annoying. It will be readily understood by reference to Figure 2, which is a diagram of a quadruplex circuit, omitting at one end (to simplify matters) the transmitting apparatus, and at the other end, the receiving instruments. Of the transmitting instruments in San Francisco, P. C. is a pole-changer that sends signals into the polarized relay P. R. in Los Angeles by reversing the currents to the line. It does this by putting the line in contact with the batteries B plus and B minus respectively, by the movements of a lever l, shown in vertical section, to which the line is attached. The lever is moved by an electro-magnet in a local circuit controlled by the key of the transmitting operator. The current strength used in operating the relay P. R. by the reversals of P. C. is small—about 20 milliamperes usually, and does not affect the relay N. R. because the retractile spring on the lever of the latter instrument is adjusted to resist the pull of its magnets. The windings on N. R. are fewer than on P. R. and the whole force of the transmitting battery, giving about 60 milliamperes, is needed

to operate the relay N. R. It will be noted that P. R. is worked by reversals of current and N. R. by variations in current strength. The transmitter T produces these variations by adding or subtracting cells from the batteries B plus and B minus, so that the transmitter T operates the relay N. R. and the pole-changer P. C. operates the relay P. R.

Now, it is in relay N. R. that the cause of vagueness in

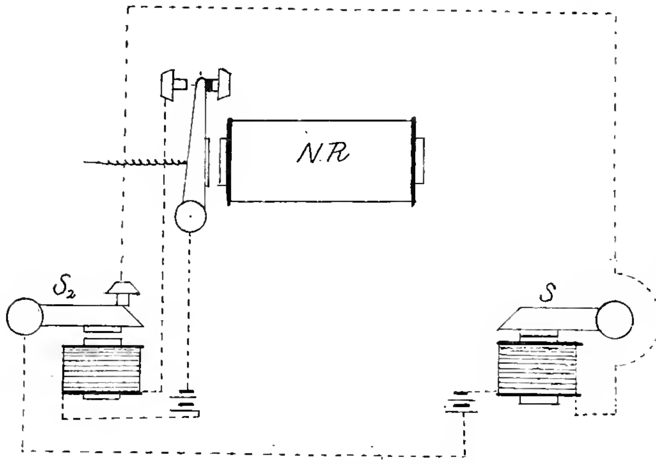


Fig. 3—Edison's Device for Reducing the Reversal Interval.

signaling shows its effects. This is the instrument that is affected; and by tracing the series of operations that take place when transmitter T. is sending a signal into N. R. the character of the interference is readily discerned. Let transmitter T. for instance be sending out the full current, closing the contact of relay N. R. at C, and closing the sounder S. through the local circuit controlled by the relay lever. Now, suppose at this instant the operator using P. C. sends a reversal into the line in signaling to P. R. The batteries B plus and B minus are short circuited for a moment through the lever 1, and then exchanged one for the other, the current on the line falls in strength and rises again to a maximum of opposite sign. The time that it takes to do this is proportional to the resistance of the circuit and to its static capacity.

The time required for a complete reversal from a maximum current of one sign to a maximum current of the opposite sign at the distant station is called the reversal interval, and this reversal interval is the cause of obscurity in signaling to N. R.; for it is plain that if the interval is not so short that the spring on the lever of N. R. has not time to act, a false signal must be caused in S by a momentary break at the contact points c, at every reversal of P. C. In practice the interval is never so short as this; and it was not until Thomas A. Edison had applied his device for neutralizing its effects, that the quadruplex could be worked.

Figure 3 shows the device of Mr. Edison, in which it will be seen that N. R. closes the local circuit on its back contact c, and that this local circuit, instead of operating the receiving sounder S directly, does it through a repeating sounder S. 2. This repeating sounder operates the local circuit through S. Now, observe the effect of this simple contrivance in obviating the disturbing effects of the reversal interval. Suppose once more, that T. Figure 2 is closed, closing N. R. Contact is broken at c, opening sounder S. 2, which closes the local circuit of sounder S. Now, when P. C. reverses, the lever of N. R. is pulled back by its spring as at first; but before it can make a false signal on S, it must close sounder S. 2, the self-induction of which is thus used to offset the reversal interval on the main circuit. The relay lever is thus re-attracted by the reversed current before its falling off has caused a false signal in S.

This device works well, provided the circuit is not so long that the combined static capacity and resistance make the reversal interval too great. Circuits longer than two or three hundred miles demand something in addition to the Edison device. F. W. Jones, Gerritt Smith and others have added devices to act on the relay armature itself, either directly by an auxiliary magnet and separate inductive circuit, as is done by Mr. Jones, or through auxiliary windings on the relay core, as is done by Mr. Smith, or directly through the main line coils, as by the writer. They all act by applying a momentary force to the relay either to hold the lever for an instant while the line is reversing, as by Mr. Jones, or by causing the relay cores to reverse very quickly, as by Mr. Smith and the writer.

It is readily seen, therefore, that the reversal interval is a serious matter in quadruplex telegraphy, and that anything that will shorten it is an improvement. The continuity preserving pole-changer of Mr. Edison P. C., Figure 2, applies the reversals to the transmitting end in the ideal way. Since the reversal interval is proportional to the static capacity and resistance of the circuit, whatever tends to reduce either quantity reduces of course, the interval. The primitive mode of signaling with double currents was by a front and back contact key, Figure 4, during every reversal of which the main current was opened. In the quadruplex this mode would increase the resistance factor of the reversal interval, not to infinity at the transmitting station as it might seem, but to the amount of the resistance in the compensating circuit shown in Figure 2 at the Los Angeles end through the relays and resistance box R. to the earth. Mr. Edison avoided this increase of resistance by short circuiting the batteries through the lever 1 of P. C., Figure 2, so that the static discharge from the line was much hastened.

But where dynamo machines are substituted for the chemical batteries in Figure 2, short circuiting through the level 1 is attended with destructive arcing at the contact points of P. C. There appeared to be no help for it but a return to primitive methods, from which was developed the "walking-beam" pole-changer, such as is used by the Western Union Telegraph Company in the East, and the type of pole-changers hitherto applied to dynamo-quads. These walking-beam pole-changers are clearly nothing more than the primitive front and back contact keys of the pre-Edison age, shown in Figure 4, except for being worked by an electro-magnet instead of by hand. They possess the bad feature of lengthening the reversal interval.

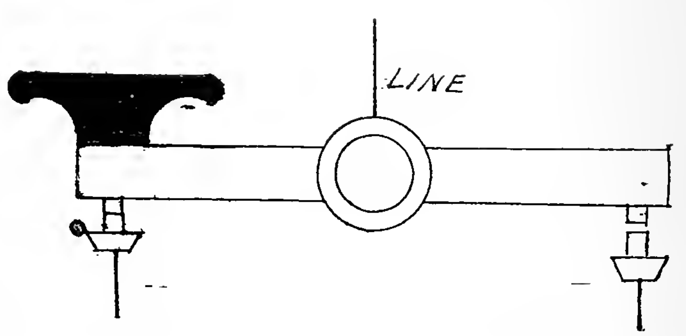


Fig. 4—The Primitive "Walking Beam" Pole Changer.

This was the experience of the Pacific Postal Company that compelled the postponement of the application of the dynamo plant to its quads. Many different types of pole-changers were tried, and many contrivances employed to put the dynamo-quad on an equal footing with the chemical.

Some of the facts brought out by these experiments, although not particularly new, are still strikingly interesting. For instance, two quadruplex sets were joined together through a resistance coil adjusted to equal the Los Angeles

circuit in resistance. It was found that the breaking space separating the contacts of the pole-changer had to be increased beyond that which was necessary when a pole line was used, else an arc was likely to form at the pole-changer contacts. This arc started as a true self-induction spark. When a pole line was used, however, the contacts could be worked much closer, and the spark was formed on making

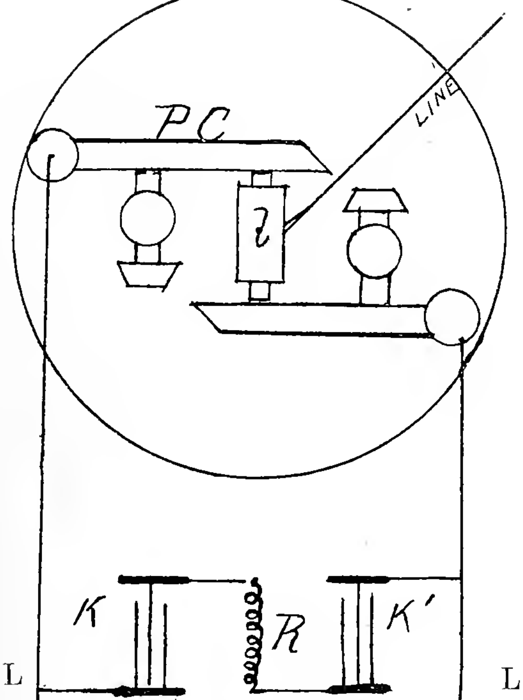


FIG. 5—THE MEDINA MODE OF SOLVING A QUAD PROBLEM IN DYNAMO-TELEGRAPHY.

contact, not on breaking it. In other words, the static capacity of the line neutralized the tendency of the dynamos to arc across the contacts, and added a little energy of its own. The theory of its action would seem to be somewhat as follows, as far as neutralizing the self-induction spark is concerned:

The dynamo charges the line to a certain potential, and the amount of this charge is proportional to the static capacity. Now, if the charge is great enough the contact point on the lever will retain, for an instant after break, something near the same potential as the contact point from which it has just parted, so that the potential difference between the two will be too small to create an arc. If it is admitted that a certain potential difference is required to maintain an arc across this air space, and the static charge of the circuit tends to prevent this potential difference, then when such an arc occurs with walking-beam pole-changers, and it does sometimes occur, it must be due to some fluctuation of the static charge that permits this potential difference to be formed. A cause of this fluctuation may be found in the bright spark at the opposite pair of contact points which occurs just before making contact. It is the static discharge from the line, and obviously if the line is discharged there is nothing to prevent the full potential difference from forming between the parting contact points, perhaps at the very moment of parting. This, I think, is the way the arc at the pole-changer contacts is formed, and not principally by the static discharge as has been held.

Corroborative evidence is furnished by the behavior of a continuity-preserving pole-changer as in Figure 2, on a circuit containing excessive capacity. The Pacific Postal Company work a circuit from San Francisco to Albuquerque—1200 miles long, the capacity of which is about double that of ordinary five or six hundred mile circuits. Now, it was found that continuity-preserving pole-changers could be used on this circuit with dynamos, if the pole-changers were finely adjusted so that the static charge could not escape before contact was broken. The discharging line seemed to momentarily stop the current in the lead to the contact point that the lever parts from, by establishing a potential equal to that of the dynamo. At least there seemed to be no current broken at the contacts. But this condition is obviously an unstable one, liable to be changed by a slight variation in the static capacity or in the time of contact. Experience showed this to be true, and the pole-changers could not be depended on not to arc.

It became more and more evident that the true solution of the quad problem lay in the application of a continuity-preserving pole-changer. The facts detailed above seemed to point out a means of applying it. If the application of a static charge could be made at the proper moment in such a way that the potential difference between the breaking points must always be small, no arc could form.

Figure 5 shows the plan devised by the writer to produce this effect, and the Honorable Commissioner of Patents of the United States has been good enough to pronounce it his invention. P. C. is a continuity pole-changer, L. L. leads to the positive and negative dynamos respectively. K. K. are very small condensers, having capacity of about twelve one-hundredths of one microfarad each, and R. is a small resistance to diminish the current of discharge from condensers K. K. when P. C. is reversing. Now, these condensers act like a variable resistance, in a well-known way, and keep the potential difference of all the contact points very small until the parting points are widely separated, thus destroying all tendency to arc. The static spark that occurs just before contact is made, is, with this device, no longer a source of arc production, and, as it hastens the discharge of the line, becomes now a desirable feature.

The stations at the end of the quad circuits report enthusiastically in favor of the new arrangement, declaring that the reversal interval is smaller than with chemical batteries. It may be that the static spark as indicated above has something to do with quickening the reversals; but at any rate it is a conservative way of putting it to say that the dynamo quad of The Pacific Postal Company is fully equal in efficiency to the best chemical quads.

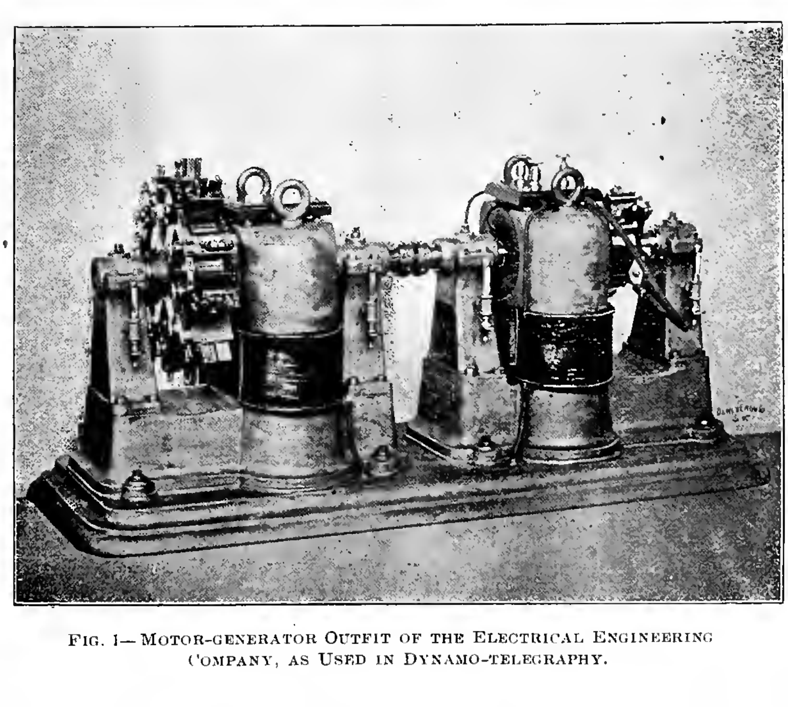


FIG. 1—MOTOR-GENERATOR OUTFIT OF THE ELECTRICAL ENGINEERING COMPANY, AS USED IN DYNAMO-TELEGRAPHY.

Hydraulics

WATER WHEEL REGULATION

The Tuolumne County Electric Power and Light Co. has recently installed a 3-phase transmission plant in Sonora, Cal., which contains several interesting features not found elsewhere. The apparatus used is of the General Electric tri-phase type, and in addition to lighting the towns of Sonora and Columbia, the company is furnishing power to the Rawhide mine. It is in this mine that a 150 h. p. induction motor has been installed for operating the main hoist. The speed of the motor is controlled by means of a special regulator resembling in outward appearance the latest type of General Electric street railway controller, and consisting of commutating devices by means of which the direction of the motor is controlled and of suitable contacts for cutting equal resistances simultaneously into the three leads of the motor.

The generating station is operated by a 48-inch Pelton water wheel running under a head of over 900 feet and as the key-note of success in the operation of this plant rested in securing the very close regulation of the water wheels, it was determined to depart from the usual types of water wheel governors to satisfy the demands. Accordingly, Mr. J. A. Lighthipe, Chief Engineer of the Pacific Coast office of the General Electric Co., designed the electric governor illustrated herewith, to meet the exigencies of the case. This governor, which is the first one built, has now been in operation for several months with such success that steps are being taken for its installation in other plants where trouble is being experienced in the governing of water wheels operating under high head.

In principle, the Lighthipe governor consists essentially of a series motor with a double wound field; that is, a field containing two independent windings, each connected in series with the armature in such a way that while the direction flow in the armature is always one way, the polarity of the field is changed according to which of the two field windings is used. To the armature shaft is direct connected a screw carrying a traveling nut which moves backward or forward according to the direction of armature rotation, and by the nut is operated a rod which in turn controls a crank operating the hood or other means of regulating the water supply. From the main shaft of the water wheel is driven a centrifugal governor by belting and this governor actuates the motor circuit through one or the other of the field windings.

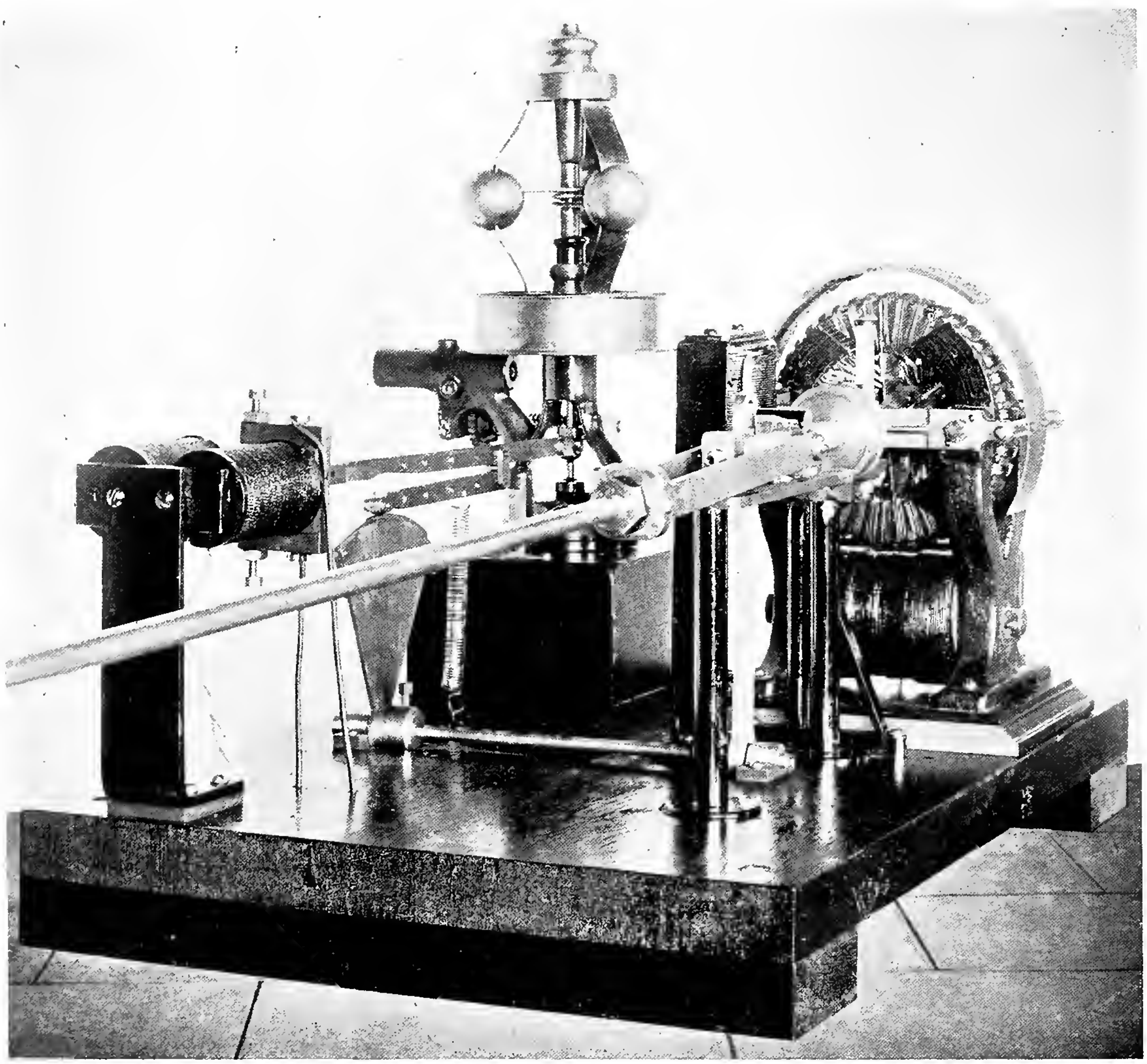


FIG. 1—THE LIGHTHIPE WATER WHEEL GOVERNOR

The troubles heretofore experienced in the governing of water wheels have been due to the slowness of the pawl method of actuation and to the fact that "see-sawing" is

caused by the action of the governor in continuing to deflect the nozzle, to a greater extent than that necessary to reduce the power of the wheel to the desired point. The nozzle, therefore, goes over the center as it were, resulting in the speed of the wheel falling below normal, which the governor attempts to correct and in doing so pulls the nozzle back over the center again giving excess speed. The process is again repeated and the "see-sawing" is under full sway to the utter defeat of satisfactory operation.

The means by which the Lighthipe governor obviates these two troubles will be understood by reference to the accompanying illustrations, from which it will be seen that the fan-like disc operated by the crank attached to the traveling nut on the extension of the armature shaft, controls the elevation of a lever that is parallel with and secondary to the governor lever. This disc constitutes a cam of varying radii as shown in exaggerated form in Figure 2 and is so adjusted that as soon as the circuit of the pilot motor is closed by the governor lever the movement of the cam by the traveling nut raises or lowers the governor lever in such a way as to break the contact before the water wheel has been brought to the desired speed, thus compensating

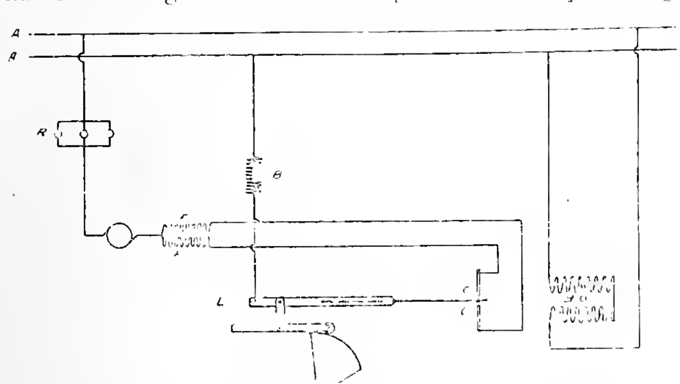


Fig. 2—Outline Drawing of the Lighthipe Water Wheel Governor.

for the inertia of the moving masses and endowing the governor with a mechanical perception of far greater sensitiveness than that heretofore attained.

The diagram appended hereto as Figure 2 will make clearer the electrical connections and operation of the governor:

A A are the mains from the exciter or other source of direct current supply.

R is a lamp resistance to reduce the current rush on closing the circuit.

F and F are the field coils wound in opposition, and constitute the device for securing reversal with only two contact points.

L is the lever operated by the centrifugal governor.

C and C are the contact points lying within the pole pieces of the blow-out magnet B O, which was added to break the destructiveness of the arc at the contact points.

B is the brake soleniod in series with the motor circuit and arrests the momentum of the armature by bringing it to an instantaneous stop upon breaking the motor circuit.

The governor is exceedingly sensitive and may be adjusted to any desired degree of sensitiveness by adjusting either the contact points C C, or the link forming the fulcrum between the governor lever and the cam lever, shown in Figure 1. The contact tips may be adjusted to within 1-16 of an inch of contact, so that the slightest change of speed will throw the motor into action one way or the other. The ingenious mechanism accomplishes a closeness of regulation heretofore unattained; and while designed primarily for the control of water wheels, driving electric generators, it may be used with equal satisfaction in any class of work, as the governor can be operated from a simple battery circuit, as well as from an exciter or an incandescent lighting service.

ELECTRICAL COAL CUTTERS.

One of the largest coal operating concerns in Ohio, Messrs. Ellsworth, Morris & Co., have decided to cut their coal by electrical machinery. The system to be employed is the three-phase system of the General Electric Company, and the plant will consist of one 135 H. P. electric generator and eight coal cutters of the new induction motor chain type. These will be placed in two mines at Trail Run and Hartford, O., distant from each other 2½ miles. The power house will be located centrally and the current will be carried for nearly two miles, over aerial wires, which will be run through drill holes into the entries of the mines and be carried to the various points where the cutters are employed. Naturally such an order as this was not secured without competition, and induction motor cutters were adopted in place of the direct current motor cutters, for the reason that, compared with the latter, the former is lighter in make, many characteristics rendering the method of applying power to the cutter superior, decreases the amount of copper required to equip the mine, has no commutator or brushes demanding constant attention, has no starting rheostat and does not spark. The fact that the operative is not called upon to devote part of his time to attending to a brush and commutator mechanism, but can outline his work uninterruptedly is an important desideratum.

The Hutson Coal Co., owning and operating coal mines at Deerfield, Portage county, O., has also adopted electrical apparatus for cutting its coal. The plant consists of one 100 H. P. three-phase generator and one six-foot coal cutter. The particular mine in which the cutter is working has just been opened. The entry is driven in only a few hundred feet and there is only room at present for one cutting machine.

WHEN WATER POWER MAY BE USED TO ADVANTAGE.

It should be advantageous to use water power when it is cheaper than any other source of power and equally reliable. The cost, however, depends largely on the question of availability. All comparisons are naturally made with steam power, which can be furnished in any location, in any desired quantity, at a cost fixed by the particular conditions. The water power may not be in the location where power is desired; the quantity of power required may not be sufficient to warrant the development of the water power by a single manufacturer, and there may not be sufficient demand for power in the particular location to warrant the development of a special company. When, however, such development has been made, a new set of conditions is set up.

The water power can then be sold, at the site, in quantities small or large, like any other commodity, and, moreover, the later developments in electricity have made practicable the transmission of power to a distance where it can be utilized in large or small units. Under such circumstances, the transmitted power is brought in competition with steam power, either as a substitute for established steam plants or as the original source of supply for new enterprises.

In order to make it commercially desirable to develop a water power there must exist, first, a demand for power in considerable quantities; second, an available water power within a reasonable distance of the center of demand, and third, economic conditions which will enable the power when transmitted to compete with steam engines where the power is required.—Dr. Charles E. Emery in Cassier's Magazine.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

THE VALUE OF COLLEGIATE TESTS

We are constantly noticing in the papers before the electrical societies important tests made by the laboratory forces of many colleges which would be of great interest and value were it not for fact that the names of the makers of the various pieces of apparatus tested is most carefully suppressed. The question at once arises as to whether the engineers making these tests are to be considered scientific investigators as they announce themselves or paid as experts in the hands of the companies. It is as much the part of the special advocate to suppress facts of use to the world, which he discovers, as it is for him to misrepresent the truth concerning tests made, and it is hard to say by what chain of argument these scientific instructors who are continually engaged in suppressing facts concerning the tests they are making justify themselves in any such course of action. We generally consider that college instructors are incapable of being purchased outright, but is it not a fact that by gifts of apparatus and favors to the colleges and to the instructors the manufacturing companies are purchasing the silence of those men who should be our guides in determining the best apparatus to be used and the best engineering methods to be employed for accomplishing a definite purpose. It is hardly surprising when we find technical journals which depend for an existence upon the patronage of their advertisers endeavoring to shield the makers of inferior apparatus, though this has been considered for many years a blot on the face of technical journalism and where the instructors of the country use similar methods we must all feel that the position of a teacher has lost much of its dignity and independence. It is true that instructors are often more poorly paid for their services than they would be paid for a similar ability used in business, but this fact is often explained by the desire for independence in thought and speech which such positions are supposed to confer, and if it is no longer true that in the college professor we can find an independent investigator and a fearless teacher of truth, we who are engineers must consider that one of our most valuable means of guidance has gone from us. Colleges are not established for the private information of individuals, but are established for the benefit of the community and sooner or later our instructors must find that they have departed from their true mission by not adhering to those principles.

A WORD OF CAUTION

The extreme depression in business of the past two years has resulted in reducing the prices for all materials to an enormous extent,, but at the same time it has been taken for granted by engineers that there has been no corresponding reduction in the quality of the materials furnished. We understand, however, that wire manufacturers have recently privately announced that they are unable to fulfil existing contracts with the best quality of insulation, particularly in rubber wires, and in some cases it has been found that the quality of these wires has been so far reduced that change can be discovered by a casual examination. Electrical engineers are very prone to assume that the quality of a material once shown by an electrical test is always preserved by the manufacturer and in consequence they avoid the expense of frequent testing. We have continually endeavored to impress the fact that this policy is an exceedingly dangerous one for the reason that no manufacturer, even with the best intentions, can continually deliver a uniform product while we all know that many manufacturers have not the intention to preserve high quality where they believe that inferior goods will not be detected. If continual tests of quality are obtained it is possible always to buy materials in the absolutely cheapest market, but it is always dangerous to accept a low bid where such tests are not possible, and at the present time when competition is keenest and when insurance inspection in the Far West is a thing of the past, it seems particularly necessary to caution those purchasing insulated wire against inferior products which have apparently become almost a necessity in the market by reason of the extreme reduction in prices.

A WESTERN ASSOCIATION PROPOSED

Proposals for the establishment of an association embracing the operators of electric light plants on the Pacific Coast have been made from time to time, but no such proposals have been received with great favor on account of the fact that the distances to be covered by the members of the association in attendance on its meetings would be necessarily great, while it was at the same time felt that on account of the comparative smallness of the installations little valuable information would be gained at such meetings to repay the members for the time and expense of attendance. During the past year striking changes in the electrical situation of the Pacific slope have made the organization of

such an association more important, if indeed not almost imperatively demanded.

Business arrangements between the electric and gas lighting companies have so far harmonized their differences that we understand the Pacific Coast Gas Association is considering the advisability of opening its doors to the managers of electrical undertakings and the great developments in power transmissions that have taken place have opened up problems in relation to water powers, long distance transmission, underground cables and many other minor points which are not discussed before the Eastern societies, for the solution of which the managers of the Pacific Coast could confer to their mutual advantage. It seems therefore a fitting time to urge upon the managers of electrical undertakings here the advisability of an association including in its membership all managers of electric plants, operators of gas plants, and of water power transmissions as well as independent electrical engineers and electrical supply houses. An association comprising such an aggregation in its membership should be formed on a basis of more than a single class of members such as is the practice of the National Electric Light Association, whose experience has proved the wisdom of the plan. The attendance of the electrical engineer and supply man adds much to the interest of the meetings in general, but at the same time it is not wise to give these members full membership rights for the reason that the temptation would be offered to mould the association along special lines and to give it a special bias which would undoubtedly impair the usefulness of the association to its general members.

Whether the proposed association could be operated more satisfactorily as a branch of the N. E. L. A. by an expansion of the Pacific Coast Gas Association or by the formation of an independent new body is a question for discussion amongst the possible members. We accordingly invite from the managers of such plants as would be included in the outline we have given an expression of opinion concerning the advisability of a Pacific Coast Electric Light Association and an expression of judgment concerning the lines on which such an association could be operated most satisfactorily.

PROBLEMS IN CONDUIT CONSTRUCTION

At the present time there is an exceedingly rapid growth of extensive long distance transmission systems, but only recently have the companies operating these systems been compelled to face the problem of city distribution. Now that such work is generally contemplated operators are called on to determine the best means of transmission through a city street. The days of overhead pole line construction may now be considered as permanently past, and while the best system of underground distribution for a large city is undoubtedly found in the pipe conduit, electrical engineers have not yet determined whether it will not yet be possible to introduce an equally efficient and less expensive construction where smaller cities requiring a smaller number of wires and less conduit capacity have demanded underground construction. The pipe conduit demands deep trenches and manholes of such a size that they may be considered as work-rooms; these manholes being located not further apart than the length of a city block, which will average about 400 feet. The size of a manhole does not depend upon the number of conduits used in the system, but upon the fact that sufficient room for the cable splicer must be furnished and accordingly the cost of this construction per unit of electricity supplied by the city mounts rapidly as the extent of the system decreases until in a small distribution such construction reaches an almost prohibitive cost. In the East this problem has not been encountered for the reason that the smaller cities are not demanding underground construction, and in consequence conduits are rarely found in cities of less than 200,000 inhabitants. On the Pacific Coast such cities are our most important centres of population and have very properly demanded underground wires wherever an extensive power transmission system has been contemplated.

Up to the present time such a demand has been met by burying the cables in wood boxes or in grooved planks, large amounts of such construction having been installed. The cables employed are of the best lead covered construction generally insulated with rubber and obtained from the East at a cost which is very great when we include the price of the cable, freight and the expense of splicing. While these cables are well spliced and are originally of the best manufacture, the conduit construction here used is one which has been universally condemned for many years. In the first place the wood used for trench boxes or for grooving has rarely been thoroughly dried and saturated with a preservative compound while little attempt has been made to exclude from the construction gases and liquors contained in the soil. All of the best experiments in underground construction have proved that wood contains acids injurious to the lead, and that the soil of a city is fatal to its life. In consequence no system of construction may be considered secure which does not require both the elimination of the wood acids from the conduits and the prevention of access of the products of the soil from the ducts. In consequence we may easily foresee much difficulty with all cables that have been laid here during the past two years from the destruction of the lead casing and of the insulator which it is protecting. It is, however, not accurate to suppose that the recognized manhole and duct construction of the East is necessary to overcome this difficulty, but on the contrary where distributions in small cities are contemplated we must look for information to the experience abroad where such installations have been made rather than to the experience of the East where they have not been attempted.

Two methods of construction unused at the present time in America are noticeably successful in other countries. The first of these consists of the burying of cables carried upon insulated supports in a trench filled with asphaltum. Such a method should not be expensive here where asphaltum of a good quality is a native product, but much study must be devoted to the system before it can be made successful. Failure has often resulted from the use of permeable supports for the conductors and from unsatisfactory cables and cable joints, so that the construction is dangerous where it is impossible to apply accurate insulation tests throughout the whole process of cable construction.

The other method which is undoubtedly successful is only adaptable to secondary distribution from sub-station transformers and consists in the use of something similar to overhead construction in large closed trenches which are made impermeable to moisture from the outside and readily drained from that which condenses in the interior. In this system bare conductors are used and there is a consequent saving of freight in addition to the saving in the cost of the insulation itself.

This problem calls for a solution by the engineers of the Pacific Coast and requires the care that only an engineer is capable of giving, but is worthy of consideration by every company endeavoring to install underground conductors for power and light transmission within the bounds of any of our cities.

Passing Comment

An Editorial Review of Current Events and Contemporary Publications.

PHOTOGRAPHY TO THE RESCUE.

An ingenious solution of the note collecting problem is explained by Reginald Fessenden in the "Electrical World" of August 22nd. Every engineer who has attempted to preserve the information contained in several technical journals has felt the burden of any scrap book or similar method while the extent of indices or digests must necessarily be limited by the amount of time possible to devote to such work. Prof. Fessenden has attached to his desk by a universal joint, a small camera capable of taking a picture 1x1½, and with this he photographs all articles, tables or diagrams he wishes to preserve, filing the negatives on a card index system. In this way he preserves true fac similes of all matter which appears to be of interest to him, and he states that the amount of time and expense entailed in the process is less than that of any known system; indeed, he goes to the extent of saying that he can copy letters by this method more cheaply and expeditiously than is possible with a press. The great defect in the method appears to be the smallness of the plates used, requiring a magnifying glass for reference to the articles where pages 10x12 are to be copied, but this difficulty is a minor one, and the size of plate used can be considered as a matter of individual convenience. Should it be possible to copy with plates 3¼x4¼, the negatives would occupy the same space as the ordinary card used in a card catalogue, and the additional uniformity might be desirable. Such labor-saving systems are important to every engineer, and we do not remember having seen one which appears to embody the principles of expedition and convenience more satisfactorily.

THE CAST-WELDING OF RAILS.

When first the mechanical success of the cast welded railroad joint seemed to be assured no doubt was felt concerning the electrical conductivity of such a great mass of metal, but from recent numbers of the Street Railroad Journal we would gather that there have been doubtful cases of high resistance with such joints, and there seems to be a growing feeling that the cast-welded joints cannot be safely employed without bonding for electric conductivity. This is on account of the fact that the rail expands during the casting and on cooling contracts to such an extent that intimate contact between the joint and the rail is lost; indeed the permanence of the cast-welded track above a track electrically welded is sometimes explained by this fact that the cast joint allows the rails to move while the electrically welded joints hold them in place and produce breakages when cold weather occasions contraction.

The theory of the cast-welded joint is that an alloy of the cast and wrought iron is made at the temperature of casting, but when previous experiments in uniting cast and wrought iron are examined it is found that such an alloying does not take place unless the amount of wrought iron present is small in proportion to the mass of molten cast iron, and as this is not the case in the cast-welded joint, it is not surprising to find that the contact between the two lacks in conductivity. Much difference in opinion is expressed by the many correspondents of the Street Railway Journal in reference to this point, but the fact that such a doubt concerning the process has been brought out by many accurate observers renders caution necessary in the use of this joint without bonding and requires further information before we can state surely that the cast-weld is the solution of the track conductor problem.

BOILER SCALE AND STEAM EFFICIENCY.

Discussing the subject of boilers and feed water recently, Professor F. B. Crocker made some terse remarks on the subject. The water used in steam boilers is obtained either from the regular city water supply or from some source such as a pond, river, or well. Which of these is best to employ depends upon the circumstances in each particular case, but in almost every instance the question of the purity of the water is an important matter. Almost any water available for use in boilers contains from 10 to 100 grains of solid material per gallon, and since a 100 horse-power boiler evaporates about 30,000 pounds of water per day of ten hours, or about 400 tons per month, the accumulation of this material becomes very considerable, assuming only half of it to be deposited. Impurities of water are of two distinct kinds: First, small particles of solid material mechanically held in suspension, the presence of which is perfectly evident to the eye, forming what is called, in plain language, muddy or dirty water. The other class of impurities are mineral substances dissolved in water, producing little or no change in its appearance or transparency. Impurities of the first kind can be removed by filtering, or by simply allowing the suspended particles to settle; but impurities actually dissolved in the water can only be eliminated by some process of chemical or physical precipitation. The so-called "hard water" is simply water containing compounds of lime, magnesia, etc., in solution, which are particularly objectionable in water for boilers, since they are deposited as a scale or incrustation upon the interior, and seriously interfere with the transmission of heat through the metal, there-

by reducing the efficiency of the boiler and also introducing a danger that it will become excessively heated and weakened. These deposits in boilers sometimes reach a thickness of half an inch or more, and are extremely troublesome and difficult to prevent or to remove after they have formed. It is estimated that scale one-sixteenth of an inch thick necessitates the use of about 10 per cent more fuel, one-fourth inch almost 40 per cent more, and half to three-quarter inch scale actually doubles the amount of fuel required to generate a given quantity of steam. These facts, and the greatly increased repairs and danger arising from scale in boilers, show the great importance of eliminating it.

ROPE TRANSMISSION.

In the London "Electrician" for August 14th we notice the abstract of a paper by Alfred Combe read before the Institution of Mechanical Engineers on experiences obtained in the rope driving of machinery. Many important points are covered and some startling announcements of practical results are given. The author is a son of the James Combe who, in 1856, first used rope driving for large powers in England, installing in 1863 a 200-horse power plant in a foundry plant which is at the present time still in operation. Lacking previous experimental information the Combes instituted a series of trials, the results of which are now announced and which, as we have said, present some remarkable conclusions. In the first place the speed of rope for maximum life and efficiency is given as amounting to only 3,300 feet per minute whereas the common practice is run ropes as high as five or six thousand feet per minute. With such a low speed of rope the power transmitted with any given rope is obviously much diminished and also the pulley sizes must be increased for fast driving. This result is partially counteracted in relation to the size of the pulley by the statement that pulleys only from 28 to 36 times the diamater of the rope are considered by Combe to give the best results, whereas engineers have generally thought that satisfactory life of rope could not be obtained with pulley diameters less than 35 times the diameter of the rope; still, as the ordinary life of a cotton or manilla rope is generally taken from at six to ten years there seems to be a margin in this direction which has been taken advantage of by Combe in his slow speed driving.

A few years ago rope transmissions were claimed to be more economical than belt drives, but recent practices have not borne out this claim, and it would appear from the statements made by this author that a mistake has been made in driving the ropes too fast and losing too much by inertia and centrifugal action. For large powers, rope drives are undoubtedly the most quiet and permanent, the system being one well adapted to the driving of large units from water wheels, while from the experience obtained in the direct connection of water wheels and electric power units we know that the hopes of the advocates of direct driving have not been sustained. May we not expect a return to indirect driving, allowing more economical wheels speeds and speeds of dynamos, even though this conclusion of Combe as well as those of other engineers using rope transmission must be carefully considered before we can conclude that we have arrived at the greatest economy obtainable with rope transmission.

THE ONLY HOPE FOR MUNICIPAL OWNERSHIP

The "Street Railroad Journal" has been recently calling attention to the success of the well appointed systems of the street railroads in European cities and at the same time the electrical fraternity in general has been discussing the surprisingly good financial showing of the Manchester municipal illuminating plant. On this side of the water, however, the technical journals have been occupied chronicling the failure of municipal plants and calling attention to the numerous accidents involving loss of life and destruction of machinery on the trolley roads throughout the country. These striking facts lead us to examine very carefully the differences in the municipal management of the cities of the United States and those of the Old World, examination showing at once that the business methods of the municipality of the European cities partakes of the character of their business houses, while with us municipalities are governed by politicians from whom no business ability is expected. In consequence we find in Germany the heads of the Public Works departments are without exception efficient engineers, and where municipal plants are established the best engineers of the country strive for the managements because such positions involve the greatest security of employment and allow the best exposition of ability. In rather painful contrast with this is the fact that in this country the offices are sinecures and easily obtained through personal influence. When a franchise is granted to a street railroad in Germany the plans are considered by all the engineers in the city employ who may be directly or indirectly concerned in the effects of its management, and in consequence the peace of the community is assured and the rights of the railroad are well laid down and duly respected. This would only be possible where the different heads of departments thoroughly understand the bearings of their work and that men of such ability are secured by the municipalities determines at once the success of their municipal undertakings. Theoretically there is no reason why a municipality should not do business as cheaply as an incorporated company, but such results can only be obtained where it is possible to divorce the business and engineering management completely from the field of politics and the caprices of election.

CONCERNING SWITCHBOARD DESIGNS.

It must be evident to anyone who has had occasion to examine the arrangement of switchboards that are from time to time published that convenience of installation and ease of manufacture are of more importance to switchboard designers than ease of handling and systematic design. This is still true notwithstanding the fact that the last three or four years has seen great development and advance in the making and laying out of switchboards. Certain ideas belonging to the manipulation of the most primitive electric lighting stations have been preserved in modern installations although these ideas seem often not to be justified in modern practice; among these earliest original conceptions we may include the installation of all apparatus on the positive side of the circuit, the arrangement of ammeters and

voltmeters to be visible at a great distance, the location of the rheostats at the bottom of the board and the installation of lightning arresters in the station on the board. To be sure some of the modern switchboard constructors have recognized the incorrectness of parts in these designs, particularly in the case of the location of lightning arresters and have introduced radical departures, but it is rarely that we find a switchboard so designed that the instruments affected by every switch and rheostat handle upon the board are so located that they may be easily observed by the switchboard attendant at the time that he is throwing the switch and manipulating the rheostat. Perhaps the extreme absurdities once common, of locating the various pieces of apparatus on the switchboard as to require the services of both an observer and a manipulator have been done away with, but we think that switchboard designers have not yet fully realized the importance of the switchboard attendant in the economy of a great central station, and it is by no means infrequent to find the attendant walking back and forth between his instrument and rheostat over a distance of from ten to twenty feet. Perhaps this is due to the fact that the switchboard attendant is generally considered to be a servant of the chief engineer and the chief dynamo tender rather than of the master of the station. But will we not in the future distinguish the importance of giving one man the entire command of the station having all the indicating apparatus under his eye and himself in the position of switchboard attendant.

If this radical change were effected and switchboards so designed as to make the apparatus easily read by the attendant, without reference to engineers or dynamo tenders at a considerable distance, great advantage would be gained in saving the cost of large instruments, long and complicated switchboard wires, and it would place the responsibility of the whole station upon the shoulders of one man. This responsibility could not be undertaken by the present class of switchboard attendants, but the change would allow the employment of a smaller number of expensive foremen throughout the station, while it would place the manipulating apparatus of the whole plant at a distance from the point of danger whenever mechanical or electrical accidents should occur. The system may be one implying a radical departure from the present methods of manipulating central stations, but it would make central station practice more nearly similar to mechanical practice, which has been tried and found sufficient in large power stations, such as ships, rolling mills, steel furnaces, in all of which systems the constant endeavor is to locate the responsibility and centralize the power of manipulation; such an arrangement having been found less liable to occasion accidents and one which reduces the importance of these unavoidably occurring.

John B. Fisken, General Manager of the Washington Water Power Company of Spokane, Wash., says: "I wish to compliment the style of The Journal of Electricity, which both as regards the general get-up and the matter contained therein, I consider equal to anything published in the country to-day, and I trust that it is proving to be the financial success which it ought to be."

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

"THE THEORY OF THE STRUCTURE OF MATTER." By James S. Alden, M. E., Passaic, N. J. Published by the author. 45 pp. Price, 50 cents.

In his introduction Mr. Alden states that: "He has spent nearly seven years in developing this theory, which is based on the assumption that an atom of matter 'consists of a vortex ring of luminiferous ether,' and as a conclusion of his seven years of study, he states: "That the combined teachings of the Bible and science seem to indicate that Faith and Ether are one and the same thing; the unit of biological being seems to consist of matter held in the form of a histological cell by spirit." It is hard to understand, however, from his more or less mathematical conclusions where he obtains the connection between Faith and Ether. Though the theory of the constituion of the matter given is not unsound should his fundamental assumptions be granted, but these assumptions involve the oft-disputed values of the density and the elasticity of the ether which, in all the conclusions, occur as a product, and which subsequently cannot be separated or evaluated except in speculation, unless some crucial tests could be imagined and performed. Lord Kelvin and Von Helmholtz have both made mathematical investigations of these questions, but never have been able to point to a possible system of experiments which would determine the disputed points, and Mr. Alden's investigations seem to leave the matter in exactly the same position as the ether vortex theory has held for the past ten years. To any one attracted by this form of speculation the pamphlet will form pleasant reading, and it may be instructive to any student who desires to apply himself carefully to such speculative reasoning. The fact that the phenomena of electricity are explained by Mr. Alden's theory does not aid us in the solution of any particular electrical problem, nor can we see that it has advanced the theory of electrical action beyond the point where Lodge carries the theory in his book of Modern Views.

APPARATUS FOR THE TRANSMISSION OF POWER BY TWO-PHASE ALTERNATING CURRENTS. Stanley Electric Manufacturing Company, Pittsfield, Mass.; 62 pp. Printed for free distribution.

This catalogue describing the "S. K. C." system of two-phase alternating current machinery is one of the boldest of the catalogues issued by any company,—boldest in its distinct claims for a special type of apparatus and in its clear cuts and descriptions of the apparatus manufactured by the Stanley Electric Manufacturing Company. In the introduction the claim is made that their apparatus is of high class and sold at a fair manufacturing profit, which at the present time is equivalent to a high price; this claim being substantiated as we all know by the business practices of the Stanley Company. The fact that this company has not been compelled to enlist in the ruinous competition that has been so disastrous in all lines of business during the late period of depression is one of the encouraging signs to all good engineers, proving that the market for good apparatus commanding good prices has not yet been completely lost.

The distinctive points of the "S. K. C." apparatus are first, the induction generator having no moving wire and requiring no compounding for close regulation; secondly,

the adherence to the true sine curve in the e. m. f. wave; thirdly, the complete electrical independence of the two phases from the machine, and finally the use of the condenser in induction motor installations. When this company first began to manufacture condensers for connection with induction motors it was opposed on both sides of the Atlantic by both theoretical and practical men; the first attempting to prove that the condensers were both useless and dangerous, and the second declaring that no condenser could be manufactured which could continuously withstand the demands of actual service. Both of these contentions have been disproved by the Stanley Company, until now no one dares any longer to contend that it has not successfully withstood the demands and solved the problem of overcoming the self induction of the motor by an auxiliary capacity along safe and practical lines. In fact, during the last three years the extension of this company has been more rapid than that of any other company installing polyphase machinery, which is sufficient proof of the practicability and success of the system. Many small towns throughout the East are installing Stanley apparatus where a motor load does not exist or is insignificant on account of the fact that while for lighting the Stanley machine can be considered as two single phase alternators, connections for power distribution can at any time be easily made, and any such demand be readily and efficiently met by these machines without serious disturbance of the lighting potential when large synchronous or induction motors are operated. A consideration of the claims of the Stanley Company is of great importance to every transmission plant, and as a means of transmission its machinery will continue to prove to be of the greatest importance to engineers of the Pacific Coast.

THE ENERGY OF A THUNDERBOLT.

Modern scientific discovery is fast unraveling the greatest mysteries of nature, and it now appears that there are but few things that are hidden from the gaze of him who looks for them in the proper way. Lightning was formerly one of the greatest enigmas among natural phenomena. Today we know that the average electromotive force of a "bolt" of lightning is about 3,500,000 volts; that the current is 14,000,000 amperes, and that the time of discharge is about one twenty-thousandth of a second! In such a "bolt" there is energy equal to 3,284,182 horse-power.

THE LIGHTNING BUG.

(With a Moral.)

The lightning bug is brilliant,
But it hasn't any mind;
He blunders through existence
With his headlight on behind.
—Chicago Record.

Just so the foolish merchant,
Whom no one can advise:
For he decided years ago
That he'd never advertise.
—Electrical Review, N. Y.

So now he's made a failure,
Which he cannot grasp "de tout:"
'Twas just because he managed
Things backward—hind-end-to.
—Journal of Electricity, S. F.

Transmission

ANOTHER BIG TRANSMISSION FOR SALT LAKE

The most notable power transmission plant yet attempted, both from the point of view of amount of power and the distance of transmission, is already under way in the State of Utah.

The Pioneer Electric Power Company of Ogden, Utah, has within the past month placed a contract with the General Electric Company for a complete 5000 H. P., three-phase plant, covering a transmission of 36 miles, from Ogden to Salt Lake City.

The power will be obtained from the fall in the canyon of the Ogden River, at a point almost within the limits of the city of Ogden. Across the head of the Ogden Canon a dam is to be thrown, and an immense storage reservoir formed, which will cover some 15 or 20 square miles of a valley in the mountains. From this dam to the power house is a distance of nearly six miles. The water will be carried through a six-foot pipe of wood for about five miles, while for the rest of the way it will pass through a six-foot pipe of rivetted steel. These pipes are fitted at intervals with automatic relief and air valves to prevent the bursting or collapsing when the flow of water is varied by changes of load. The effective head of water at the power house will vary from 400 to 450 feet, and the full capacity of the pipe line will be 10,000 H. P.

Two duplicate receivers will be used, one at each side of the power house, so that either can be shut down without stopping the plant. To these the pipes running to the water wheel nozzles will be connected. The speed of the wheels will be controlled by Knight governors and the valves will be operated by hydraulic pistons so that the generators may be stopped and started from the switchboard. The water from the wheels on each side of the power house will pass into a central tail race under the floor between the two lines of generators, and will be conveyed into canals for the irrigation of some 18,000 acres of land in the vicinity of Ogden, which will be reclaimed for farming purposes.

The electric plant at first will consist of five 1000 H. P. 24-pole, three-phase generators, driven by Knight water wheels running at 300 revolutions per minute. The water wheels and fitting will be furnished by the Risdon Iron & Locomotive Works of San Francisco. The water wheel and armature are to be mounted on the same shaft, and will be supported by the same base frame and bearings. The periodicity of the current is 60 cycles per second, and the generators will be wound for 2,300 volts. Two exciters, each of 100 K. W. capacity, direct, connected to their own water wheels, will be provided, either of which will suffice to excite the fields of all the generators in the completed station.

The current from the generators will be carried by lead-covered cables laid in ducts between the generator foundations and the wall of the building, to the generator switchboards at one end of the power house. The boards will be blue Vermont marble panels, and will be completely equipped with all the necessary controlling and regulating instruments and apparatus. Tachometers on the switchboard, operated by Synchronous motors electrically connected to the generators, will indicate the speed of the machines.

The step-up transformers and the 2,000 and 15,000-volt feeder panels will be placed in a gallery erected over the generator switchboard. The transformers, nine in number, each of 250 k. w. capacity, will raise the generator potential

from 2,300 volts to 15,000 volts, at which pressure 2,000 H. P. will be transmitted to Salt Lake City. The local distribution of the balance at Ogden will be made at 2,300 volts.

The transmitted current will pass over six No. 1 wires strung on insulators of a special porcelain, developed by the General Electric Company, to withstand high potentials, to nine 250 k. w. step-down transformers at Salt Lake City, which will deliver it at 2,300 volts for distribution.

The transmission line and transformers will be arranged to allow of the use of a potential of 25,000 volts. This will permit of the efficient transmission of current to the mining regions of Mercur and other camps thirty to thirty-five miles beyond Salt Lake City. All lines will be protected by the latest types of General Electric lightning arresters, which have proved so efficient in the Folsom and other transmissions.

To construct the iron and wooden pipe bringing the water to the wheels 100 h. p. in motors are set up in the shops of Rhodes Brothers, in Ogden, supplying extra power for the work, which is one of the most extensive pipe line contracts ever undertaken—five miles of six-foot wooden stave pipe, and one mile of six-foot rivetted steel pipe. Practically all the work will be done on the ground, the steel being received in flat sheets, to be rolled, punched and rivetted in the shops and the lumber for the wooden pipe in the rough to be milled, planed and put together on the spot.

Salt Lake City, with the completion of the Pioneer plant, will receive power from two of the most important electrical transmission installations ever undertaken. That transmitting the power from the Big Cottonwood Canon has only recently been completed, that of the Pioneer Company will probably be inaugurated about the first of November of this year.

A NOVEL SHUT-DOWN.

For two hours and a half Monday night the electric lights went out in Pendleton and the city was in total darkness. The explanation furnishes an account of a very peculiar occurrence, which would not happen at any station more than once in its history. During the evening the lights began to grow dim, and the station men thought the wires were grounded, and as a consequence the engine was overloaded. The incandescent lights were first turned off, but that did not remedy matters. The large driving belt connecting the engine with the dynamos was running in a most peculiar manner. It was jumping up and down and striking the stone work as it had never done before. Then the arc dynamos were cut out and the engine shut down.

William Burgess, the superintendent of the works, had come up to the station to see what was the difficulty, and he soon discovered that the big belt was literally lined with thousands of the white millers, which are now so numerous in Pendleton. One by one, dozen by dozen, the millers had flown into the open window, and had been drawn by suction into the belt until it was one mass of crushed millers.

Chalked cloths were in use in wiping the belt, and at 12:45 this morning the lights were again turned on. During the remainder of the night no more trouble was encountered.—Pendleton (Ore.) East Oregonian.

THE CHLORIDE BATTERY AGENCY GIVEN.

The sole agency for the Pacific Coast for the Chloride Electric Storage Battery has been given to the Union Iron Works, of San Francisco. Mr. A. E. Brooke-Ridley, the well known agent of the Siemens-Halske Electric Company, has been appointed general manager for the Chloride agency, which is now prepared to fill orders promptly from stock.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

The construction of the immense plant of the Mariposa Electric Power Company, and the harnessing of the mighty waters of the Merced river, hitherto allowed to go to waste, means much for Mariposa. Valuable gold mines that are now lying idle and unproductive for the sheer want of power to operate them will be opened up, giving employment to hundreds of men. Large mills will be erected to handle the products of these mines, and the roar of stamps and the whir of machinery will be heard throughout the length and breadth of the land, demonstrating the fact to the world that in Mariposa county is indeed "California's richest gold field." The building of this vast power plant is not an idle rumor, it is a real thing, and prominent and influential men of wealth of San Francisco are interested in the enterprise, and it will not "go through" for the want of money to carry on the work.—Coulterville (Cal.) Miner.

People who have experienced any trouble with street-car employees, and they are legion, will be interested in a little "letter" that has just been issued by the Haywards electric road. It marks a progressive step, both in the prestige and deportment of motormen and conductors. It commences by stating that the advice if followed "will be of great benefit to you and will tend to make you more useful to the company."

Above all things, the company does not want "cranky" men, although it expects every employee to be thoroughly familiar with all the cranks and wheels of the machinery under his control. A conductor must certainly have a temper like Job if he honestly acts up to the advice regarding being pleasant.

"When asked for information," it says, "hasten to give all that you can. A conductor can, by being cranky, drive travel from the railway, just the same as a clerk in a store can drive trade away.

"Urbanity is capital, without which no business can be successfully carried on.

"Passengers do not always like to make requests, and their wants should be anticipated.

"Do not get out of temper when a passenger happens to take offense, but rather make an effort to appease him and please him."

Something new is found in the rule about putting an obnoxious passenger off the car. Before ejecting him the conductor is to use every means to pursuade him to be a gentleman, and if this has no effect then return his fare and bounce him. The return of the fare is a new feature.

The poor conductor has another task which is not any more pleasant. He is advised as follows:

"Should a light of glass be broken while a car is in your charge, endeavor to collect $1.50 from the person breaking it. If he refuses, ask him his name and address, and when you turn your car in make a full and detailed account of it and drop it in the timecard box.

"No conductor is to discriminate between the lady who is fair, fat and fifty, and the dainty maiden who is attending a picnic at San Lorenzo Grove." He is told to be "ready" at all times to assist ladies, both old and young, in alighting or getting on a car; also to help them with bundles, etc., always to be careful when assisting a lady to do so in such a manner as not to give offense. Always try to find seats for passengers by making children "double up, or by having their parents take them on their laps."

The conductor is dismissed with one more word of advice, doubtless the result of a talk to a newspaper man in the past.

Here is the rule: "You must not, under any circumstances, discuss an accident, excepting when ordered to do so by the Superintendent."—San Francisco Call.

Personal

Mr. John I. Sabin has returned to San Francisco after spending the summer in Europe.

Dr. Thomas Addison, manager of the San Francisco office of the General Electric Company, is now in the East, and will probably not return before the middle of October.

Mr. Keijiro Okamoto, of the Department of Communcations, Tokio, Japan, and who has been in the United States for several months past on a tour of investigation, has returned to his own country.

Mr. L. J. Grimesey, of the firm of Bagnall & Hilles, of Yokohama, Japan, has been in the city for the past few days, with headquarters at the offices of the New York Insulated Wire Company, No. 18 Second street. Mr. Grimesey will visit the principal Eastern cities before returning to Japan.

Mr. H. H. Morehouse, of the firm of Morehouse & Morrill, which recently signed the contract for a complete hydraulic and electric installation costing $70,000, for the city of Antigua, Guatemala, is in San Francisco, and will place orders for materials for the plant referred to.

Financial

SAN JOAQUIN ELECTRIC COMPANY.

The San Joaquin Electric Company, of Fresno, Cal., operating the interesting and highly successful power transmission plant described in the April number of this publication, has issued a statement concerning its financial affairs, from which it appears that the total authorized bond issue of the company is $800,000, of which amount $350,000 has been reserved to meet the cost of future extensions as may be required, and can only be used under strict reservations. The present or first bond issue is therefore $450,000, maturing in twenty years and bearing 6 per cent interest. Four securities, as follows, are offered on the bonds:

First—The San Joaquin Electric Company has acquired $275,000, or nearly all of the shares of the Fresno Water Company, which has paid annual dividends of 5 per cent. and 6 per cent. for several years past, and which has often been called the model water works plant in the United States. Moreover, the recent introduction of electric power has reduced the operating expenses of the water company and materially increased its efficiency.

Second—Its entire new transmission plant built by the General Electric Company is now in highly successful operation, furnishing nearly all of the power and light used in Fresno, and yet using but practically one-fourth of the plant capacity.

Third—The title to valuable water rights on the North Fork of the San Joaquin river, the surveys, rights of way, construction work, real estate, etc., acquired, and also valuable city and county franchises and contracts.

Fourth—Contracts with the Sperry Flouring Company, the Fresno Water Company, and various other parties, all being held as security with the bonds.

The income and operating expenses of the company are stated to be as follows:

Income from the Fresno Water Company, on the basis of the year 1895	$12,000	
Sundry income contracts now on hand	42,000	
Estimated income from other contracts now being negotiated	6,000	
Present income	$60,000—	$60,000
Estimated income from future contracts per engineer's report	$20,000	
Estimated saving of expense for fuel and engineers of Fresno Water Company	6,000	
	$26,000—	$26,000
Total income		$86,000
Operating expenses during construction, first year	$16,000	
(Operating expenses after construction is completed is estimated at $10,000.)		
Interest on bond issue	27,000	
Fixed charges	$43,000—	$43,000
		$43,000

The engineer points out that the income will increase each year and the expense will diminish after the first year, and it will be observed that without regard for future prospects the present income actually being collected exceeds by $17,000 the interest and expenses. The mortgage or trust deed is approved by the attorneys of the San Joaquin Electric Company, the Municipal Investment Company, of Chicago, and the Mercantile Trust Company, of New York, trustee. A portion of the bonds are offered for sale by the Municipal Investment Company, of Chicago.

THE SAN FRANCISCO GAS AND ELECTRIC COMPANY.

The San Francisco Gas Light Company, by J. B. Crockett, President, has issued a notice to its stockholders, as follows:

"For some time past here has been sharp competition in the lighting business between the San Francisco Gas Light Company and the Edison Light and Power Company. The Boards of Directors of the two companies, realizing that possibly in the future this might lead to serious loss to both companies, and that the business of furnishing light and power should be controlled by one management, and thus effect a large saving in the general management, establish more uniform rates between gas and electricity, and in many other ways curtail expenses, have deemed it advisable to form a new company, to be known as the "San Francisco Gas and Electric Company," and to transfer to this new company all the property of the other two. This agreement was reached after a patient investigation of the affairs of both companies. The books were experted and the machinery examined, and the result is that the Directors of this company now recommend to the stockholders that they agree to the formation of the new company, the general plan or prospectus of which is as follows:

"The new company to be formed from the other two companies to be called the San Francisco Gas and Electric Co. Capital stock, $20,000,000, of which $10,000,000 will be issued to the stockholders of the San Francisco Gas Light Company; $2,750,000 to be issued to the stockholders of the Edison Light and Power Company, and $1,066,666 2-3 to be placed in trust in the hands of a trustee selected by the directors of the new company, which said stock is to be placed in escrow for the purpose of redeeming the outstanding bonds of the Edison Light and Power Company. All the remainder of the stock is to be held in the hands of the company, and will not be issued unless necessity requires the same for the enlargement, exten-

sion or improvement of the plant. The San Francisco Gas Light Company, having but its current monthly debts to pay, could disincorporate and go out of existence, but as there are real estate and other assets remaining in the corporation, being the exclusive property of its present stockholders, it will not disincorporate but will reduce its capital stock to $3,000,000, which is sufficient to carry the real estate unsold.

"It will be necessary for all the stockholders of the San Francisco Gas Light Company to surrender their present stock and to receive in exchange therefor an equal number of shares of stock of the San Francisco Gas Light Company, representing the real estate interests, the par value of which will be $3 per share, and also to receive the same number of shares of the San Francisco Gas and Electric Company. You will see by the enclosed notice that, according to law, a special notice has been issued and will be published for the necessary time, sixty days, calling a special meeting for the stockholders, to be held on Monday, October, 26th, for the purpose of approving the reduction of the capital stock as mentioned above. At the same time it is desirable to get the consent of the stockholders to the transfer of all property rights, franchises and privileges of this company to the company to be formed. We believe that, with economical management, the new company will be able to earn and pay a fair dividend, and gradually be able to reduce the price of light to the consumer.

"This projected formation of a new company has received our close attention for the past year. We have carefully investigated every detail connected with it and we believe that this action if confirmed by the stockholders will be of great advantage to us all. Therefore, if this explanation meets with your approval we will be very glad to have you sign a proxy empowering the Board of Directors to carry this out, or if you can be present in person where we can give you a full and complete statement in detail of the matter, we should prefer that."

Reports of the Month.

COMMUNICATION

RIVERSIDE, CAL.—The City Council will shortly add a number of new boxes to the fire alarm system.

LOS ANGELES, CAL.—A new district telegraph system is being organized for this city, and it is probable that the Salisbury & Dean Combined District Telegraph and Telephone System will be used.

INCORPORATION

SAN FRANCISCO, CAL.—The Fraser Electric Elevator Company; capital stock, $100,000, of which $500 has been subscribed. Directors, E. M. Fraser, Geo. Crocker, Chas. E. Green, John J. Mahony and A. J. McNicoll. Mr. Crocker is President, Mr. Mahony Vice-President, and Mr. Green is Secretary and Treasurer. The office of the company is rooms 199 and 200 Crocker building, and the works are with A. J. McNicoll & Co., No. 124 Main street. The company proposes to build and install the differential electric elevator equipment described in a recent issue of this paper.——Mariposa Electric Power Company; capital stock, $1,000,000, in 100,000 shares at $10 per share, all subscribed by the incorporators, Augustus H. Ward, Geo. Ecker, Chas. T. Lindner, Wallace B. Taylor and Harold C. Ward. The proposed plant is to be located at the old Broad Bend dam in the Merced river in Mariposa county, whence power will be distributed to the mining industries in and about Coulterville.

LITIGATION.

PHOENIX, ARIZ.—The Hirschfeld Electric Light Co. is to enter suit against the City Council to restrain it from cutting certain wires that the company has extended beyond block 21, in which the company had received a franchise for operating an electric light plant for the use of its owner and others situated in that block.

LOS ANGELES, CAL.—Judge Ross, of the United States Circuit Court, has rendered a decision in the case of Chas. D. Ranning, receiver of the San Diego Land & Water Company, vs. H. C. Osborn et. al., to the effect that the company could fix the water rate in default of any order by the Supervisors to that effect. The suit was an injunction to restrain the defendant from bringing injunction suits against the receiver or the company, and it is believed will serve as a precedent for companies rendering service at rates fixed by legislation.

SAN FRANCISCO, CAL.—The Mutual Electric Light Company has filed suit against the City and County Assessor to restrain him from collecting a tax on the assessed value of the company's franchise, and, further, to have the franchise declared null and void. The principal claim advanced by the company in defence of its suit is that it holds no special privilege or franchise, inasmuch as it operates under the State law granting any person or concern the right to lay pipes or conduits under the streets of any incorporated city for the distribution of artificial light.

SEATTLE, WASH.—The Minneaplis Trust Company has brought suit against the Seattle Gas and Electric Light Company, in the Superior Court. The plaintiff claims that the company was indebted to it in the sum of $10,000, and on September 1, 1893, made a promissory note in that amount, payable one year after date. To secure the note the gas company pledged 2990 shares of its capital stock with the plaintiff. The plaintiff asks judgment for the $10,000, with interest and a foreclosure and sale of the pledged gas stock, to pay this amount.

TRANSMISSION.

FRESNO, CAL.—The 150 k. w. 1040-volt General Electric three-phase synchronous motor installed in the Sperry Flour Mill is now in regular operation by the San Joaquin Electric Company, and is rendering highly satisfactory service.

CITY OF MEXICO, MEXICO.—Francisco Espinosa & Co., and the Siemans & Halske Electric Company are along bidding for the city lighting by electricity, and should the contract be awarded to the former concern the power will be taken from the Tequisquiac tunnel debouche.

HELENA, MONT.—The Helena Electric Power & Water Company is rushing work on its power-house site at Canyon Ferry, on the Missouri river, where a dam is to be erected, giving a head of about 25 feet. An excavation of 150 feet by 75 feet is being made for the power house on a piece of land reclaimed from the river bed by a coffer-dam.

RIVERSIDE, CAL.—The transmission circuit for the Riverside municipal plant between the Redlands power house and this city is completed. It is twenty-miles in length, the poles are 30 feet long and set 120 feet apart, and the circuits are of No. 3 and No. 4 B. & S. gauge.——The Board of Trustees has made the following appointments of employees for the municipal electric plant: F. A. Worthly, general manager; Geo. A. Johnson, sub-station attendant; William Thomas, lineman, and F. C. Sweetser, Elmer Cutting and F. E. Seburn, trimmers.

OGDEN, UTAH.—The installation of the Pioneer Electric Power Company's transmission plant is progressing satisfactorily, and new contracts are being awarded almost daily. The

last important one being to Rhodes Brothers for the completion of a section of pipe line to cost $18,000. About $350,000 has been spent in preliminary work, and it is estimated that at least $1,500,000 additional will be required to complete the plant. The Weber Club, formed for the purpose of promoting the interests of Ogden, is making every effort to induce manufacturers to locate in Ogden.

PACIFIC GROVE, CAL.—The Survey Corps of the Little Sur Electric Company has completed the final survey for the pole line, its length being 21 3-5 miles of very rough country. The pole line and the large two-mile flume will be the heaviest items of expense. It is understood that the work on this power plant will soon be under way. Machinery has arrived from San Francisco to complete the water system at Carmelito, five miles from Monterey. There has been a large reservoir built, and the water will be brought from the San Jose creek. Carmelito is owned by the Carmel Coal and Land Company.

TRANSPORTATION.

OGDEN, UTAH.—Local papers are discussing the probability of an electric railway from this city to Salt Lake City.

SALEM, OR.—Thomas Holman has bought the property of the Motor Railway Company, on receiver's sale, for $4310.

PORTLAND, OR.—Use of steam on the Mount Tabor branch of the City & Suburban Railway has been discontinued, and the line is now operated electrically.

POMONA, CAL.—The Board of Trustees has repealed ordinance No. 21, rescinding a franchise to the Orange Grove Street Railway Company, because of failure to operate for six months.

SAN BERNARDINO, CAL.—The San Bernardino, Arrowhead and Waterman Motor Railway Line is now in operation, the equipment consisting of two steam motors and five cars. Oil is used as fuel.

SANTA MONICA, CAL.—The Santa Monica & Soldiers' Home Street Railway Company has been granted the right to change its line to a single or double track electric railway system, and also to extend its existing system.

SANTA BARBARA, CAL.—The track-laying for the Consolidated Electric railway system is completed, and the complete electrical equipment, including cars, is on the ground. The road will probably be in operation during the latter part of September.

SAN JOSE, CAL.—L. M. Hale has been granted an extension of time for six months from September 13th in which to commence construction on the proposed electric railway from the western boundary line of the city of San Jose to Saratoga, in Santa Clara county, and of one year from September 13, 1896, in which to complete and place in operation said railway.

SANTA ANA, CAL.—A number of local business men, headed by M. A. Menges, have paid $200 on a ninety-day option for the purchase of the Santa Ana, Orange & Tustin Railway system for $4000, and it is hoped that arrangements will be completed by which the line may be again placed in operation.——A Mr. Simms is negotiating for the purchase of the Santa Ana Gas and Electric Light Company's plant.

SAN FRANCISCO, CAL.—The Mill Valley and Mount Tamalpais Scenic Railway, extending from Mill Valley to the Summit of Mount Tamalpais, a distance of about seven miles, and affording a superb view of the Pacific ocean, the Bay of San Francisco, and all neighboring cities, was opened with fitting ceremonies on August 26th. The road is at present operated by steam, but it is intended to ultimately equip the road with electric traction.

SEATTLE, WASH.—W. J. Grambs, receiver of the Grant street electric line, filed a report with Judge Hanford for the first six months of the year 1896. The gross earnings of the road from January 1, 1896, to June 30, 1896, both inclusive, aggregated $12,861.72 and the operating expenses aggregated $11,161,01, leaving a surplus of $1700.71. Fares were collected during the six months amounting to $10,424.07, freight $59.05, revenue from power $435, lighting $1842.55, and other sources $101.05.

ILLUMINATION.

FORT JONES, CAL.—Manuel Pareira's electric light plant is now in operation.

GLOBE, ARIZ.—Chas. Barker's electric light plant will be in operation by October 1st.

SILVERTON, OR.—Coolidge & McClaine have bought the electric light plant for $3104.

QUINCY, CAL.—An electric light plant is assured, if favorable water rates can be secured.

FERNDALE, CAL.—The Ferndale Electric Light Company has placed its Westinghouse plant in operation.

DOWNIEVILLE, CAL.—A central station has been established in this town, using Westinghouse apparatus throughout.

MENDOCINO, CAL.—The Mendocino Electric Company have been granted a fifty-year franchise for an electric light plant.

JACKSON, CAL.—The Bellweather mine is now being lighted from the circuits of the Amador Railway & Light Company.

KASLO, B. C.—The City Council is receiving propositions for a light and water system, having floated $30,000 in city bonds.

COLTON, CAL.—The Board of Trustees has adopted ordinance No. 141, establishing rates for incandescent lighting service.

BENICIA, CAL.—The Solano Electric Light Company has installed a 750-light T. H. alternator, forming an addition to its plant.

ETNA, CAL.—The Etna Development Company intends to put in a water works, after which it will install an electric light plant.

COLUSA, CAL.—Certain San Francisco parties are endeavoring to induce the Board of Trustees to consider a proposition for a municipal plant.

ANGELS CAMP, CAL.—The Utica Electric Light Company has installed a 150 k. w. Westinghouse incandescent alternator, doubling its former capacity.

HERMOSILLO, MEXICO.—J. P. Wattson is erecting a municipal lighting plant here under authorization of Governor Corral, of the State of Sonora.

TOPIA, MEXICO.—H. T. Lloyd has purchased two 30 k. w. Westinghouse alternators, complete with marble switchboard and equipment for use in this State.

JUNEAU, ALASKA.—A 120 k. w. 1100-volt Westinghouse alternator, complete with marble switchboard and station appliances, has been installed by the Juneau Electric Light Company.

FRESNO, CAL.—The San Joaquin Electric Company has secured the contract for lighting the County Hospital buildings, and the contract for lighting the new Court House is practically assured.

MAYFIELD, CAL.—The Peninsula Light Company has been

granted a county franchise for the erection of electric light circuits, for a period of two years, from San Francisquito creek to Mayfield and Mountain View.

DOUGLAS ISLAND, ALASKA.—Thomas Quinn is erecting for the Alaska Treadwell Mining Company a 100 k. w. direct-current eight-pole Westinghouse generator, to be used for lighting the mine. The plant is wired up for 3000 lamps.

BISBEE, ARIZ.—E. P. Mason, of the Bisbee Water Works, has been considering the advisability of installing an electric light plant therein, to have a capacity of about 1000 incandescents and 25 arcs. The Copper Queen Consolidated Mining Company's mines may possibly be lighted therefrom. Coal costs $12.60 per short ton, delivered.

TACOMA, WASH.—The city electrician, Emil Bachelet, recommends the installation of a 3000-light alternator, to meet the demands of new business.----Ordinance No. 1120 has been established, fixing the residence rate of incandescent service from the municipal plant at 25 cents flat, the meter rate at 0.6 of a cent per lamp per hour, and the minimum rate being $1.

MISCELLANEOUS.

SAN JOSE, CAL.—An elaborate electrical display is being prepared for the county fair. Address W. W. Gillespie.

COTTAGE GROVE, OR.—The foreman of the Champion mine states that a hoisting plant will be installed, to be operated with power taken from the tramway.

SEATTLE, WASH.—Andrew Hemrich, Judge Sapp and others, of this place, are about to put in an electric plant to operate compressed air drills at their mines on Miller creek, near Skykomish.

OREGON CITY, OR.—Dr. J. C. Perry, of San Francisco, and W. C. Cheney have been experimenting on the use of the Roentgen ray for the purpose of determining the existence of free gold in quartz. The experiments were highly successful.

SACRAMENTO, CAL.—Thomas O'Brien, a lineman in the employ of the Sunset Telephone & Telegraph Company, was instantly killed on August 27th while on a pole by coming in contact with an uninsulated joint in a primary circuit carrying 1000 volts.

BODIE, CAL.—N. Westheimer, of New York, President of the Bodie, Bulwer and Mono mines, has recently been inspecting their properties, and it is stated that a result of his visit will be the erection of a transmission plant for the mines. It is believed that the power house will be located within seven miles of Bridgeport, on the Sweetwater and Bridgeport road.

NEVADA CITY, CAL.—A 250 h. p. synchronous motor, taking two-phase current at 5000 volts from the power and lighting circuit of the Nevada County Electric Power Company, has been installed in the Gold Hill mine, where it has been successfully operating all the hoists, together with a Cornish pump, a double-acting Dow pump and an air compressor for pneumatic drills for several weeks. A recent fire caused the loss of about $1500 to the Electric Power Company in poles and wires burned.

LOS ANGELES, CAL.—The newspapers are warning the public against a "glib young man," who has been exhibiting the "Wonderful X-Rayograph" to hundreds of people. The outfit has been experted, however, and has been found to consist of angle mirrors, by means of which vision is carried around rather than through blocks of wood.——The Los Angeles Electrician Union has elected the following officers: President, F. S. Roney; Vice-President, James Hammersley; Secretary and Treasurer, John Lloyd; Executive Board, F. S. Roney, S. L. Colburn, Charles Evans, Thomas Storie, A. H. Miller, F. A. Beem.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Elec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

The Journal of Electricity

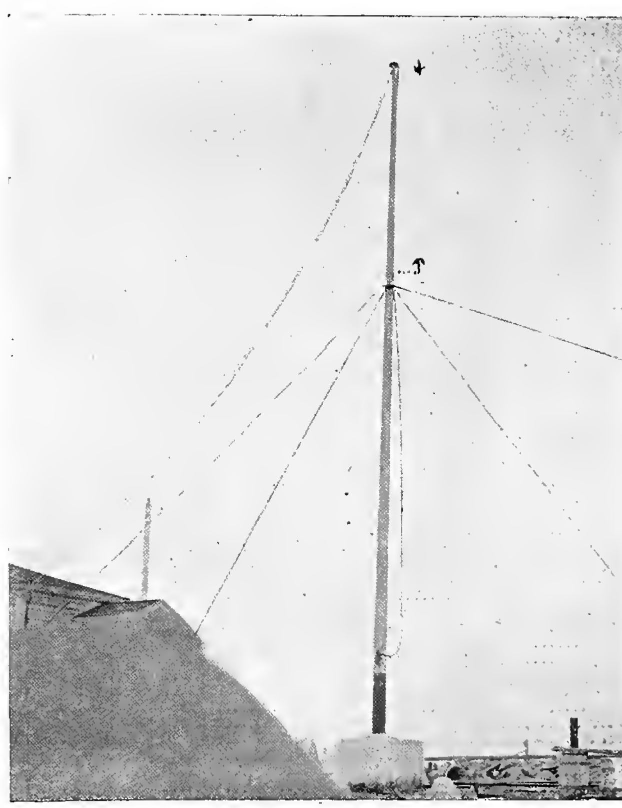
Vol. III. SEPTEMBER 1896. No. 3

Lightning in California.

By ALEX G. McADIE, Local Forecast Official.*

On one of the busiest corners of San Francisco, in the office of a large electrical company, there has been prominently displayed during the present summer a number of lightning arresters with placards calling attention to the principles of their construction and their probable efficiency. There are also some photographs of vicious-looking lightning flashes, which the writer was at no loss to recognize inasmuch as they were some he had himself made in the East. The fact that there should be such an exhibit is not without significance, because it has been generally believed that the Pacific Coast, or at least the southern half of it, was a region free from thunder-storms, and that damage by lightning was practically an unknown quantity. One is well within the bounds in saying that protection of life and property from danger by lightning has been hitherthe total damage in the entire country west of the to considered a matter of no importance. It is true that Rocky Mountains is but a small fraction of the total damage done by lightning east of the mountains. But for any accurate comparison the density of population should be considered. In the East, damage by lightning occurs between the months of April and September; the maximum damage occurring in June. It may occasion some surprise to Californians to read that thunder-storms occur in California throughout the whole year. The records of the past year show that there was but one month free from thunder-storms.

The accompanying table, compiled chiefly from the records of the California State Weather Service, shows the distribution of thunder-storms in this State from July, 1895, to August, 1896. Doubtless there are many places not mentioned here where storms occurred. In all there are 356 reports. If we take the different dates we find that there were three dates in July on which storms occurred; six in August; eight in September; ten in October; none in November; three in December; five in January; two in February; three in March; nine in April; fifteen in May, and six in June, twenty-two in July 1896, and seventeen in August, 1896.



THE 'POINT LOBOS SIGNAL FLAG POLE.—SPLIT AS INDICATED BY THE ARROWS.

There is a remarkable increase in the months last named. Some of the storms covered very large areas and were quite generally reported; such for example as Oct. 14-15, 1895; May 29, July 24 and August 28-29, 1896. I have found on examining some marine reports

*Published by permission of the Weather Bureau, Washington, D. C.

that on January 25, thunder-storms prevailed in the Pacific Ocean at 125 degrees and 155 degrees north latitude and probably in the region between. In fact it was a condition favorable for thunder-storm formation and it is therefore not surprising to find that a day or two later thunder-storms occurred throughout California. These storms apparently moved inland from the West.

There is another class of storms however, which does not find its origin over the ocean. These are storms which come from the southwest. Given a condition favorable for thunder-storms in the valley of the Colorado River in July and August, one may look for thunder showers within the following ten hours in the lower part of the San Joaquin Valley.

Whether lightning is dangerous in California the few following notes will make plain:

On January 26 the plant of the Haywoods Electric Light Company was struck by lightning. The electrician, Mr. J. Putnam, is reported as saying: "I was not more than twenty feet away from the dynamo when the crash came, and it seemed as if the lightning filled the whole building. The flame shot out from the dynamo about eight feet and the wires, magnets and mica were thrown all over the place. I instantly ran to the switchboard and disconnected the wires and there was no more light that night. The accident was a very simple one and one that will be guarded against in future. The lightning was conducted to the machine by one of the wires, and of course the dynamo was instantly overcharged and burnt....There is one hole and no trace of the missing metal. The wires that sur-

The Distribution of Thunderstorms in California.

STATION.	County.	Elevation.	1895						1896								
			July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	
Bodie	Mono	8248	16–21	12	20								22–23	22–28–24	4-5-21-23-25	12-17-18-19-22	19
Briggs	Yolo	51				14–15		15									3
Centreville	Alameda				8	14–15											3
Crafton	San Bernardino	1759								29					4	16	3
Crescent City	Del Norte	50						14	21	29		9	29			29	6
Durham	Butte	180						15					29			30	5
Descanso	San Diego	3400							29					13	9-10-12-13-24	14-15-27	3
Edmanton	Plumas	4750		26	17–18	15–16 19–20–21			17–26				28		5-15-16	22-28-30	10 17
Evergreen	Santa Clara	150											6				1
Follow's Camp	Los Angeles	800										10	6			16	3
Fort Bragg	Mendocino							20	18–26								3
Folsom City	Sacramento	182				20					27	24	6–21			22-30	7
Grass Valley	Nevada	2090							29	29		9–24	29			22-30	7
Greenville	Plumas	3600		26	17–28	15–20				29					5-15-24-25	22-23-24-28-29	15
Guinda	Yolo				13	14–15			26				28		5		6
Georgetown	El Dorado	2750									26						1
Iowa Hill	Placer	2825		27	18	19			17–29		26	24				29	8
LaPorte	Plumas	5000			18	19			17			18	28	25	5-15	22-28-29	11
LaGrange	Stanislaus	293			18												1
Lick Observatory	Santa Clara	4209				14–15							6				3
Lime Kiln	Tulare					18–19				29	25–26–27						6
Lodi	San Joaquin	32								29	27	26			25		4
Los Angeles	Los Angeles												7				2
Los Gatos	Santa Clara	83											28			19	2
McMullen	Fresno							15		18	26		8		3-4-7-12-17-24	20-29	12
Middletown	Lake	1300											22–23		29	29-30	5
Milton	Calaveras	650								29							1
Mokelumne Hill	Calaveras	1550											28–29				2
Mt. Glenwood	Santa Cruz					15											1
Napa	Napa	95				13–15–16						15					4
Newcastle	Placer	956										24				18-22	3
Niles	Alameda	87							26			15				19	3
North Bloomfield	Nevada	3000			18											22	2
Oleta	Amador	1510				12-18-19-20			29		26	24	28				8
Orangevale	Sacramento	300								29	27					22	3
Ontario	San Bernardino											9					1
Pasadena	Los Angeles	875			26–27												2
Paso Robles	San Luis Obispo	880											6		4		2
Peachland	Sonoma	200							26				6–29		10	19-20	6
Pichaco	San Diego								28						9-12-13-14-15 –18–24	14-19-26-27-28	13
Pilot Creek	Plumas												7–29		5-15-16-25-26	17-22-29	10
Placerville	El Dorado	18				15–16–17			29	29	26–27	16–21			25	22	11
Quincy	Plumas	3350		26					17–21				28–29		15		2
Reedley	Fresno												6		4-5-22-24		5
Rio Vista	Solano	11											6		10		3
Roseville	Placer											16–24	8–9–18			21	2
Rosewood	Tehama	865				17–20				29		18–19	23	1–26	5-15-25.27-28	19-20-23-28-29-30	22
Sacramento	Sacramento	35				15							28			22	3
San Francisco						15			26			16–24	29				5
San Jose	Santa Clara					14							29			19	3
San Miguel Island	S. B.	500				19											1
San Leandro	Alameda	48				15			26				29				3
Santa Clara	Santa Clara	83				14										20	2
Santa Cruz	Santa Cruz	25								29					22	18	3
Shasta	Shasta			19		17–20			28		26–27	18–21–29	2–3–23–28–[illegible]		17-26-27-28	20 27	20
Snedden's Ranch	Ventura								27			10					1
Summerdale	Mariposa											24					1
Susanville	Lassen	4195			17								8–2[illegible]			19-23	3
Turlock	Stanislaus	106													4-25		3
Ukiah	Mendocino	620			17			20					6–2[illegible]		10-29	22	7
Upper Soda Lake	Lake	1300											28–2[illegible]		10-27-28-29		6
Ventura	Ventura	50							27							17	2
Washington	Nevada	2140										29			15		2
West Point	Calaveras											29			25		2
Wire Bridge	Placer	565										24			25	22	3
Yreka	Siskiyou	2635	3	28–29									23–29–31	1–2–30	25-26-27-28	19-20-21	16

round the magnets were so highly charged that they flew in all directions and when the mica was free it fell around in showers. It will take several days to fix the wrecked machine. If I had been oiling that dynamo when the lightning struck I should have been charred to a cinder as rapidly as that piece of iron was burned."

At Folsom, on the 24th of April, lightning struck the lines of the Electric Light and Power Company five times and the machines went out of step at each stroke. The lightning arresters were burned and discolored. On April 9th, at Ontario, two strokes of lightning entered the Electric Power House. Wires were burned and a coat belonging to one of the employees set on fire. "The first stroke, it is stated, came from overhead, while the second struck the wires miles away and came in when the sky was clear overhead. Lightning conductors were under the floor but had not been connected, as it was thought there would be no use for them. After the first stroke they were connected and occurred. Notwithstanding that much of it was grounded by the new conductor, it did more damage in the power house than the former, showing that it was much the heavier charge."

The Fresno Republican of October 17th, reports that: "A heavy thunder-storm in the hills caused the shutting down last evening of the entire electric plant of the San Joaquin Electric Company for twenty minutes. The lightning passing over the lightning arrest- had just been made ready, when the second discharge ers caused the points to become welded together, forming a short circuit across the two lines. Occurring at a time when the city was in darkness the delay in repairing was greater than it would have been during the day. No great damage was done to the machinery."

In the city of San Francisco, houses and barns have been struck and some damage done. A large cypress tree on the southeast corner of Broderick and Green streets was riven from branch to root. A very large branch was torn off and thrown some little distance. On August 19th, this year, the signal flag pole at Point Lobos was struck by lightning and badly damaged. The pole was sixty feet high and the upper twenty feet were so torn that a new pole was necessary. Large splinters of wood were thrown over 150 feet away. Lights were burned out at the terminus of the Sutro Electric railroad and other damage done in the vicinity. In the light of what has happened, it would be unsafe to leave life and property unprotected by appropriate conductors and arresters. It may not be out of place to conclude this article with a few directions for procedure in cases of persons struck.

1. Make the stricken person breathe by artificially imitating the respiratory movements of the chest.
2. Keep the body warm.
3. Send for a physician.

Some very interesting experiments upon the electricity of the air at San Francisco have been made this summer by the U. S. Weather Bureau. With large kites Mr. Hammon and his associates have succeeded in getting marked electrical effects. These kites are for the most part of the Hargrave pattern and are flown by means of fine steel piano wire, from the roof of the Mills building, about 185 feet high. Altitudes of 4,100 feet have been reached. The roof has a covering of tar which probably makes a good insulator; for one can ordinarily stand and touch the wire without receiving

EXPERIMENTS IN ATMOSPHERIC ELECTRICITY.—KITES AND KITE FLYING FROM THE MILLS BUILDING.

a shock. If one touches a wire leading to the ground and at the same time attempts to touch the kite wire, the charge is generally sufficient to shock one severely. On some occasions, when the sky has been covered with clouds, the electrification has been so strong that no one could touch the reel or wire until these had been grounded. With a condenser there is no difficulty even in clear weather, in getting large sparks.

It has been often shown that the potential of the air can be obtained through kites. At Blue Hill Observatory, near Boston, with tin-foiled kites, electrical condensers Thomson Mascart and multiple quadrant electrometers and hemp kite string wound with copper wire the writer made many experiments upon the electrification of the air. The most general points brought out were:

1. With increase of elevation of the kite, there was an increase in the potential.
2. The potentials were generally high, sometimes thousands of volts.
3. We could obtain sparks from a perfectly cloudless sky and often at an elevation not exceeding 500 metres.
4. During thunder-storms the phenomena are usually pronounced.

At San Francisco it has been demonstrated that the air was highly electrified, apparently just the same as along the Atlantic seaboard. There is no doubt that the upper air strata are untapped reservoirs of electrical energy. The current may be feeble but the potential is very high.

We hope to continue experiments in this direction.

Electro-Economics

SOME STATION ECONOMICS.

BY LIEUT. W. STUART-SMITH, U. S. N.

When boilers are working under normal conditions, with even and steady firing and fairly uniform work being done by the engine so that the withdrawal of steam from the boiler is not subjected to rapid and violent changes, the water of entrainment carried by the steam into the steam pipe varies little from hour to hour, and when the amount is once determined it can be counted upon to maintain an approximately steady value. It is carried by the projection into the steam space of water which is broken into fine spray by the twisting bubbles of steam as they rise rapidly to the surface (under considerable tension) after being formed on, and liberated from, the heating surface. The heavier particles at once fall back, but the lighter ones are carried along by the current of steam, in very considerable amount if the steam space is small or if the boiler is making steam very rapidly, and in lesser amount with slow steaming and ample drying space, the exact amount depending upon the design of the boiler and the method of working. In all cases it is present in the steam which flows towards the cylinder, and as the distance from the boiler is increased the amount of moisture carried by the steam is augmented by the water of condensation which is constantly produced in the pipe, the amount being a function of the temperature difference between the steam and the external air and of the surface exposed to the air, the nature of the surface determining the radiation and consequent loss of heat by the steam. The water thus carried is detrimental from three causes; its temperature is the same as that of the steam, say 300 deg. to 350 deg. F., and the heat required to raise it to this temperature from the temperature of the feed water is entirely wasted; its pressure greatly reduces the elasticity of the steam and consequently lessens the amount of work the steam would be capable of doing if it were dry; it enhances the reduction of temperature of the cylinder walls during expansion owing to the large amount of water which lies against the walls and is evaporated as the pressure falls towards the end of the stroke, the reduced temperature of the walls causing a considerably greater amount of incoming steam to be condensed than would be the case if the steam were originally dry.

Owing to the causes enumerated, wet steam may occasion a very considerable unnecessary expenditure of fuel and as many plants are working very close to the dividing line between profit and loss and the managers give little concern to the small economics because they know nothing about them, it is well to call attention from time to time, to things which every station operator should know. Obviously the best cure for the disease caused by wet steam is to prevent, as far as possible, the steam becoming wet. It is impossible entirely to prevent any water of entrainment being carried forward by the steam, but it may be reduced to a very small amount by; (1) ample steam room in the boiler or drum so that the velocity of flow of steam will be very small before it enters the pipe; (2) ample water surface so that steam need not enter the steam space in the form of large bubbles, such bubbles being under considerable tension and bursting with considerale force as they reach the surface, breaking the water into fine spray and throwing it into the steam where it is held in suspension and passes with the steam into the pipe; (3) heating surface from which the small steam bubbles are easily detached as fast as formed, if this cannot occur large bubbles will be produced which must attain very considerable tension before they can liberate themselves; (4) free and rapid circulation so that the water in all parts of the boiler will be as nearly as possible at the same temperature and the water currents will sweep the small steam bubbles from the heating surface and thus prevent the formation of large and explosive ones. All these points are embodied in the design of every good boiler and can be obtained by exercising judicious care in purchasing. To purchase a boiler of poor design because it is cheaper in first cost is the most expensive economy. No particular type has a monopoly of these good points as they may be found to an equal extent in return tubular, locomotive tubular (sectional or otherwise) or combinations of these.

Condensation in the steam pipe cannot be entirely obviated but it can be very much reduced by taking proper precautions. Obviously the pipe should be as short as possible as this reduces the surface from which heat can be radiated; also vertical sections should be avoided to as great an extent as possible as the volume of air sweeping over a given length of vertical pipe is much greater than that over an equal carried away is greater and the condensation is in direct proportion to the heat wasted.

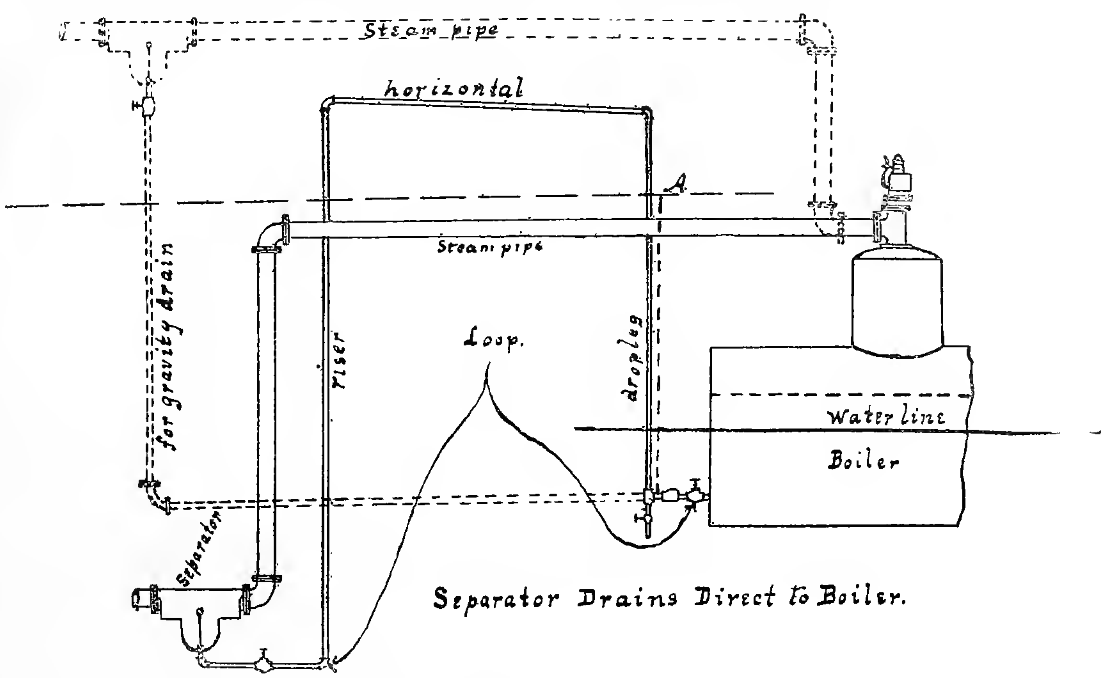
Covering the pipes to prevent radiation is a common practice which should always be followed. Care should be used in selecting a covering, the idea that anything which will not burn is good enough being a fallacy. Some so-called non-conducting coverings permit a waste of three or four times as much heat as others which will cost but a few dollars more to apply.

When the best of care has been taken to reduce the moisture in the steam to a minimum there still remains a considerable amount which should be removed if the highest economy of the steam entering the cylinder is to be obtained. For this purpose a good separator should be placed as close to the cylinder as convenient. There are several of these on the market

which are highly efficient and, if properly installed and managed, will pass to the cylinder practically dry steam. The management of these consists mainly in keeping them well drained, as it is found by experience that if the water in the reservoir is allowed to rise above a certain height the steam sweeping over the surface will carry the water with it and no further separation will take place. Though a drain cock is an integral part of every separator and a glass gauge is (or should be) fitted for showing the height of water in the reservoir, reports constantly come from sections that the steam is very wet even when a good separator is of the trouble required for replacing. Usually, however, they are kept properly drained, the pipe leading to a trap and thence to the hot well from which the fitted and examination frequently shows that the gauge glass has been removed as a useless appendage or, having been broken, has been thought unworthy water is taken by feed pump and returned to the boiler.

The accompanying sketch shows two methods of direct draining to the boiler. The dotted lines show the steam pipe, separator and drain pipe arranged for gravity drain. This can be accomplished whenever the lower part of the separator is at a distance above the water level of the boiler greater than the height of a column of water which will balance the difference of steam pressure at separator and boiler. This is indicated by the dotted line at "A." If the separator is not above this line an attempt to drain by gravity would result in flooding the separator and possibly the cylinder. A steam gauge applied to separator will show the drop and a simple calculation will indicate whether gravity drain can be adopted in any particular case.

The full line drawing shows a simple device for direct drain whenever the separator is below the level of the dotted "A." This device is called a "steam loop" and deserves to be much more widely known



Separator Drains Direct to Boiler.

This is good practice as far as furnishing by steam is concerned but neglects one of the small economics, the summation of which frequently determines the financial success or failure of a station. The quantity of water constantly passing through a separator is frequently of very considerable amount and while it is in the separator and in contact with the steam it has practically the temperature of the steam, say, on an average 330 deg. F. After it leaves the separator, mixes with other water, and is exposed for a time to the air the temperature falls to say, 190 deg. F., at which temperature it is admitted to the boiler. This is a loss of 140 thermal units per pound of water, aggregating for a day's run, many pounds of coal burned which would be saved if the water was returned to the boiler at a temperature but little below that which it has in the separator. As this direct return is readily accomplished there is no excuse for the waste.

than seems to be the case. Its function is to produce an artificial head in virtue of which the water collected in the separator may be returned to the boiler against the difference of pressures existing in the separator and boiler. The sketch shows the elements of the device and the principle of its action is readily explained. From the bottom of the separator a pipe called the riser extends to an elevation somewhat greater than the height of a column of water, equaling the pressure difference between separator and boiler, this pipe may be vertical or part vertical and part horizontal as may be convenient, the essential feature being that the upper end must be at the height indicated; from this upper end a pipe called the horizontal leads away towards the boiler and has sufficient slope to cause any water which may enter it to flow towards the boiler; the horizontal terminates in the drop by which, as is the case with the riser, may have any direction so long

as it is generally downward; it terminates in a connection to the boiler below water line.

The action is as follows: With a difference of pressure between the separator and the boiler, if the stop valves at the separator and the boiler are opened, water rises in the drop by to the point "A," when the water column balances the pressure difference and the system is in equilibrium with no tendency to motion in any direction. The drop leg and riser are clothed with a good non-conducting covering, but the horizontal is uncovered so as to permit free condensation of steam within it; under these circumstances rapid condensation takes place with the result that the equilibrium previously existing is destroyed and the pressure in the horizontal is less than in other parts of the system. The contents of both drop leg and riser rush upward in an attempt to restore the equilibrium, but the contents of the drop leg is water while the riser is filled with a mixture of steam and watery spray many times lighter than the water in the drop leg. The result is that the contents of the riser will pass into the horizontal when the water will separate from the steam and, by virtue of the downward slope of the horizontal, will flow into the drop leg and thence by gravity into the boiler. As condensation is continually taking place in the horizontal, steam from the separator is continually passing upward through the riser, sweeping with it the water which enters the separator and preventing any accumulation. The action is absolutely continuous and once started will work continuously with no attention whatever, returning to the boiler all water of entrainment and condensation with but a trifling lowering of temperature. As the water is lifted against a head equal to the difference between pressure in the boiler and that in the separator work is done, the necessary energy being obtained from the steam which is condensed in the horizontal. To start the loop, steam must be blown through it to remove the air and supply steam for condensation in the horizontal.

Under ordinary conditions the water collected by any separator should be comparatively steady in amount but experience shows that very considerable quantities of water of primage can be readly handled by the loop. A primage is very erratic, however, and frequently causes large quantities of water to pass into the steam pipe, a large waste drain with valve should be fitted to the separator in order that such erratic flow of water can be quickly disposed of.

Primage is usually said to be incapable of being properly accounted for, but in land boilers supplied with an unvarying quality of water, there is little excuse for it and when it occurs it may be put down as the result of carlessness and inattention. Either the boilers are very unevenly fitted and one is required to guarantee steam at an abnormally rapid rate or else the water has been allowed to become very dirty and greasy. In marine practice passing from salt water to fresh, or vice versa, as when passing into or out of a river will frequently cause violent priming if deficiency of feed is made up from the water in which the vessel is steaming. When it frequently occurs in land practice, a new fireman will probably prove the best panacea.

A source of considerable fuel waste in many stations is insufficient diameter of steam or exhaust pipes, or both. With a high speed non-condensing engine, too small an exhaust is common. Cases are frequently seen in which the expansion, exhaust, back pressure, compression and admission lines are excellent but in which the steam line falls towards the point of cut-off at a very considerable slope. Such a card invariably shows too small steam passage somewhere between the boiler and the cylinder and if it is not locally choked it is certain that the steam pipe is too small. A pipe which is of ample diameter for a short lead may cause a very heavy drop if the engine is at a considerable distance from the boiler.

With a high speed, non-condensing, engine the exhaust pipe is long and as the steam must be very quickly discharged under a small pressure difference between the cylinder and the atmosphere, the pipe should have much larger capacity then would be necessary with short exhaust to a condenser. Cards are frequently seen in which the back pressure line quickly rises three or four pounds as the piston gains headway after the crank passes the center, a difference of pressure which represents several horse-power. When an engine gives such cards the pipe should be very much enlarged and shortened if possible.

Another fruitful source of waste is an idea, which is prevalent among station managers, that a Corliss engine has no equal for any purpose. The writer has in mind a plant near San Francisco where a Corliss engine is belted to a jack shaft from which are belted two machines which could be direct belted from the two wheels of a high speed engine at a saving of several per cent in power. The manager had been a small bookkeeper before becoming manager, but he very soon learned all that in his estimation was to be known about an engine. Similar arrangements are common.

Oil is sometimes wasted. A station not far from San Francisco ran for several years with an oil expenditure of fifty dollars per month. A competent station man took charge of the overhauling of the plant and with the same engines and dynamos the oil expenditure was reduced to seven dollars per month.

It would pay many a station manager to have proper examination made of the small economies which seem too trifling to bother about or about which he knows nothing.

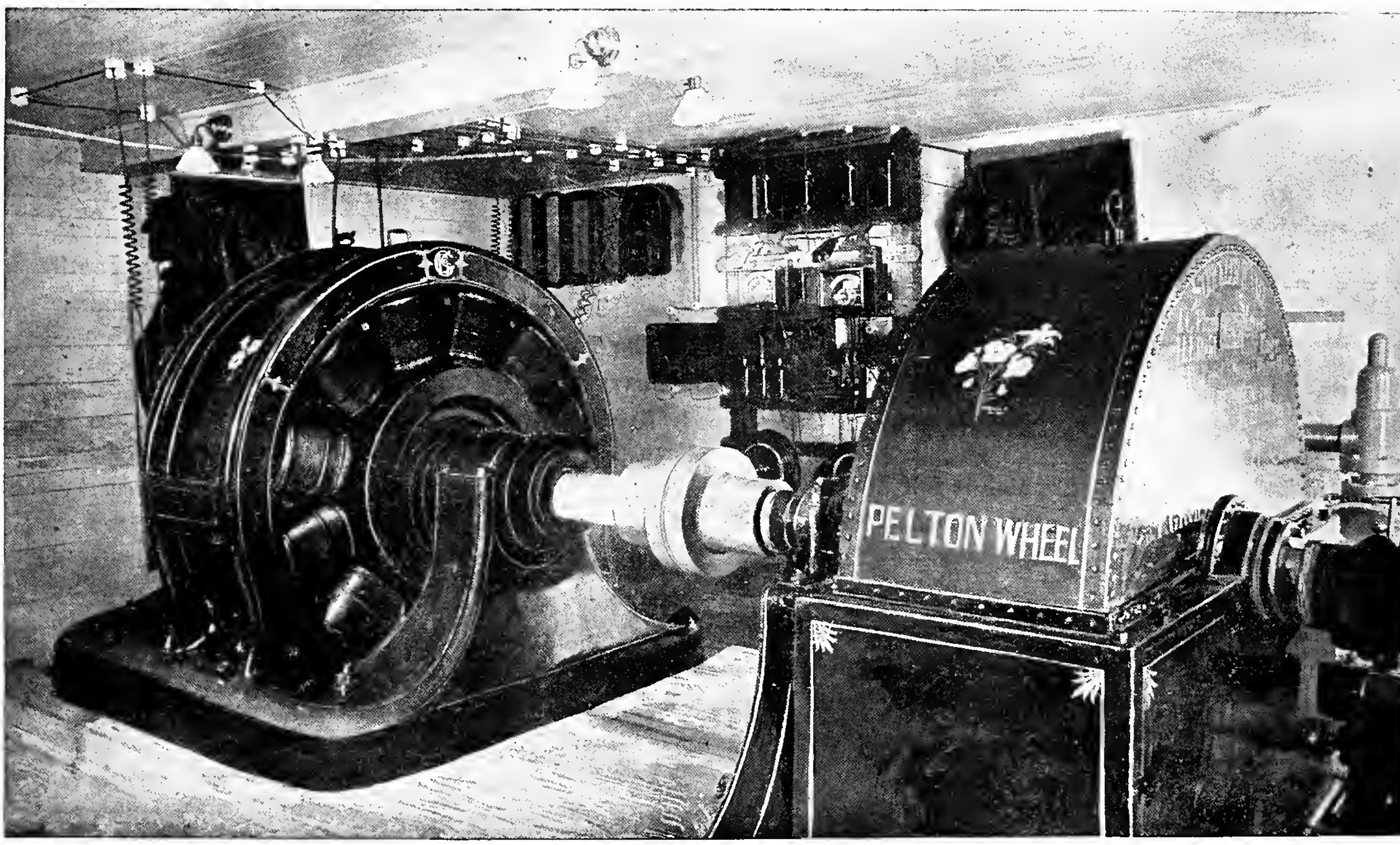
THE MANITOU TUNNEL POWER PLANT.

The station of the Manitou Tunnel Power Plant is located a short distance above the Iron Springs Hotel, at Manitou, Colorado, and consists of a 500 h. p. Pelton Wheel direct -connected to a General Electric Company's generator. The wheel runs under a head of 600 feet and is speeded at 600 revolutions per minute.

The power thus generated is carried a distance of 8 miles and runs an air compressor for supplying the drills operating in what is known as the Strickler Tunnel, which is being driven through a spur of Pike's Peak range. This tunnel is 6.400 feet long and forms a part of the new Water Works system of Colorado Springs. Operations on the tunnel are carried on from both ends, and light as well as power is supplied from the station for the power house as well as all underground work.

This is believed to be the first instance in which the brought to bear upon a project of this character. The facility it has afforded for the rapid and economical prosecution of the work has been a gratifying surprise to all interested in the enterprise.

The 13-inch drain supplying Colorado Springs carries a pressure at the reservoir of 170 lbs., which it is now proposed to utilize, by means of Pelton wheels tand electric generators, for lighting the city.



THE MANITOU TUNNEL POWER PLANT.

NEW STEAM SPECIALTIES.

Among the new agencies recently awarded to the H. N. Cook Belting Company of San Francisco for steam specialties is one worthy of special consideration, namely, the "P. P. P. Diagonal Rod Packing," manufactured by Charles A. Daniels of Philadelphia. In this packing one side is an absorbent cushion for oils, which keeps the rod well lubricated and prevents the danger of breaking the gland or putting undue friction on the rod. The other side is composed of the best materials for wear in the stuffing-box and is made in wedge shapes, which, under pressure from the glands, slide on each other, thereby compensating for the wear made by the rod.

It is claimed that this is a perfect rod packing, as it is the most elastic packing under all conditions, and by its use is obtained the minimum amount of friction and the minimum amount of wear. It is impervious to the action of steam, oils, acids, alkalies and sulphurous waters, and is a perfect preventive against the loss of ammonia in the ice machine. It works equally well on the heavy mining pumps and the most sensitive valve stems. On the steam hammer there is no indication of "drip" and it is not affected by the vibration of the rod. It is the only packing that is an absorbent of the lubricants, insuring a film of oil on the wearing surface and adapting itself to all conditions of the rod, and all inequalities of the stuffing-box and is equally adapted for the hydraulic elevator or the air pump. It is more pliable, hence more quickly and easily applied than any other. It is the most economical, requiring less frequent packing—none is thrown away, but simply a round is added when needed. Less steam used—or allowing a greater number of stokes per minute with same pressure; it may be run by tightening glands with fingers only. It works equally well running at high or low pressure.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY
F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

H. A. HEYWOOD - - - - Business Manager

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EDITORIAL.

ANNOUNCEMENT.

Mingled with the regret which is felt in craving the indulgence of the readers and patrons of "The Journal" for the lateness of its issue, the proprietor enjoys great satisfaction in announcing the appointment of Mr. H. A. Heywood as Business Manager, who, in assuming the new position, renders it possible to reclaim promptness and easily advance "The Journal" to the high plain of excellence to which it has aspired.

THE VALUE OF ASSOCIATION.

Notices in the current electrical papers of meetings of the Electro-Therapeutic Society in New York call to mind the fact that the existence of an association for mutual action and the exchange of ideas throughout the country, mark the rise from local interest to wide application in any industry. All who are engaged in any common line of work find that their own interests are furthered rather than prejudiced by helping their fellows and receiving help from their co-workers. It is only when the man of business is small that extreme distrust of neighbors is felt. With increase in power, increase in knowledge is required and at the same time, jealousy is removed. Applying these principles to the condition of the electrical industries of the Pacific Coast makes us again convinced that the time has come for the establishment of an association for mutual help and protection.

EMPLOYMENT THE YEAR THROUGH.

With the approach of winter many electric railroads are operating a smaller number of cars and laying off many motormen and conductors who were engaged for handling the summer excursion business. That this should be necessary seems to be a great disadvantage to any company, and we believe that a proposal which will reduce the necessity of such action would be approved by managers as well as by their employees. Some time ago we commented upon the importance of teaching car men the construction of the machinery under their charge by employing them in the repair shop during the time they were on the extra list and it is pleasing to find that such a system has been extended by any electric railroad to such an extent that the force does not become disorganized during the months of small travel. Such a system has been inaugurated by the Tramways Company of the Isle of Man where a heavy summer travel is succeeded by an exceedingly light winter load.

In that island the car men have been recruited from the local blacksmiths, painters, cabinte and carriage makers and during the winter months these men are employed in renovating the entire plant, repainting cars, repairing motors, etc. Many power companies have, during recent years, rebuilt cars, rewound motors and done their own repairs and have saved much money by doing work of this kind in their own shops. It certainly seems that much of this work could be done in the slack season with the summer force and that the system would tend to give them a better and more reliable class of workmen all through; having their employer's interests well at heart, besides effecting much saving in the general management of the company.

THE RATING OF ELECTRICAL MACHINERY.

Having occasion a short time ago to examine the efficiency curves of a set of motors furnished by one of the large manufacturing companies, we were struck by the fact that these motors were rated at from 25 per cent to 50 per cent beyond their load of maximum efficiency, a practice differing decidedly from the established custom of steam engineering where the power of engines are invariably rated at the load of maximum efficiency. This high rating for electrical machinery

seems to be a survival of the time when the heating of a machine alone was considered as limiting its power and when efficiencies were rarely considered and still more rarely measured, indeed, a few years ago it was found by the operators of electric reduction and aluminium plants that no machines manufactured in this country were capable of operating at their rated loads for 24 hours without overheating, and in consequence these ratings seem to give neither their maximum capacity for continuous service nor the maximum capacity for efficient service, but rather represent the loads that can be carried for a short period of time, or in other words the capacities which must not be exceeded under any circumstances. This fact is very confusing to the central station designer who endeavors to install machinery in such a manner that it will give the best possible continuous station efficiency, for no matter how well designed and chosen the specified size of machine as taken from data at hand, there is no guarantee that in an open competition machines will not be purchased which will not be operated at much different efficiencies from those intended in the design, and in consequence the present practice has the effect of a handicap upon careful designing. If it is necessary for machines to be sold on the basis of their greatest possible output, should not also the most efficient load be stated by the manufacturer and a careful engineer given the opportunity of applying his ability in the choice of machinery to give a high average efficiency under a particular system of operation.

DISREPUTABLE PATENT COMPETITIONS.

We have recently received a copy of a paper called the "National Recorder," issued by a firm of Washington patent attorneys claiming that a million copies of their journal are regularly printed and who offer monthly medals and prizes for especial ability in invention, to inventors taking out patents through their agency. This is one of the many "catch-penny" devices bringing discredit upon the patent system of this country. In the heat of securing prize money, young men and mechanics are induced to take out patents upon unsalable inventions, squandering money and time to the ultimate benefit of no one except the patent attorneys. Perhaps for sale abroad such a medal may give an undue importance to a trivial invention, but we cannot see any way in which such a system can be of advantage in legitimate business. No one who has ever patented an invention has failed to receive from one or more companies very flattering letters concerning the value of his invention and its patentability abroad with the offer of a medal or a diploma for a small fee, though the fee is always much greater than the value of the medal received and there is no intent on the part of the grantor of the medal beyond the deception of the unfortunate patentee who may be allured by their flattery. There are in France and in this country respectable patent competitions whose medals attest the excellence of inventions, but these competitions are not administered for the purpose of inducing applications for patents through particular firms, but are offered by such institutions as the Franklin Institute and the French Institute for the encouragement of national industry. These legitimate prizes are not fictitiously offered and their awards have real value while such schemes as those presented by the firm in question can only have the effect of increasing the number of useless patents and of bringing discredit on the whole system of issuing patents.

FINANCE AND ELECTRICAL INDUSTRY.

It is not often that we find technical papers indulging in political discussions which may be explained from the fact that their business connections are too complicated to allow them to become exponents of one or another shade of political opinion but, during the present campaign, we find that the electrical newspapers either consider that their constituencies are all of one mind or that the questions involved are of too great importance to allow personal advantage to interfere with the patriotism of the editors. By whatever reasoning we may explain the fact (and personally we believe the last to be the true state of the case) no one of the electrical papers coming to our table has hesitated to express its opinion on the financial planks of the two contending parties, and what is yet more remarkable, we find that they are unanimous in condemning the free silver platform announced by the Chicago Democratic Convention. These papers are the mouthpiece of an industry which while being one of the largest and most widely diffused in the country is administered by the most highly educated men at present employed in any trade. Furthermore, the electrical undertakings throughout the United States are heavy borrowers of money, both at home and abroad and one would perhaps expect that such borrowers might find some satisfaction in repudiating

part of their indebtedness; the practical effect of free coinage of silver.

In spite of this partial advantage to certain companies we do not find and commendation of the scheme proposed for the free coinage of silver. To be sure in many cases bonds have been placed by electrical undertakings which are payable in gold and where this is a fact, nothing but disaster could follow the introduction of a cheap dollar. Perhaps their bills for wages and coal could be met as well under the new basis as under the old though their proportionate interest charges, which now amount to from 10 per cent to 20 per cent of their entire expense, would be immediately doubled. Indeed, it seems impossible to us to understand how business men can reasonably endure this proposed solution of the financial difficulties in this country whether they consider their own integrity or their own personal advantage. Should it be possible to immediately obliterate and start anew all business undertakings, the existence of a cheaper money would not necessarily prove a hardship; but no such revolution is possible; the future must be faced with past obligations in full view and integrity would demand that money which has been borrowed without stipulation should be paid without depreciation. Where money has been borrowed payable in gold such a payment must come from the earnings, and if the value of the net earnings in terms of gold is depreciated the time of possible repayment is correspondingly lengthened. We hope that these facts are already sufficiently apparent to manufacturers of every kind and at the same time trust that those engaged in manufacturing will feel a personal interest in the credit and personal integrity of the community at large which will turn the tide on election day in favor of a system which will not disturb but which will strengthen the national credit.

Mr. Harvey L. Lufkin, the genial manager for the Cocker-Wheeler Electric Company of New York, and who has been intimately associated with the leading electric motor interests of the country from the incipiency of the industry, is in San Francisco with headquarters at the offices of the Pacific Coast managers for his company, the Abner Doble Company.

Mr. G. F. Kutz, after many years service in the Navy, has resigned from the engineering staff at Mare Island to enter the employ of Messrs. Chas. C. Moore & Co., upon whom the employment of so eminent an engineer reflects great credit.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

THE INACCURACIES IN JOURNALISM.

We have from time to time noticed errors made in electrical papers and have regretted that such errors should show either carelessness or ignorance on the part of the editors, but we do not remember having seen so surprising a piece of misinformation as that contained in the "Electrical Age" for September 25th, where under the heading "Spectrum of Sodium" it is stated on the authority of Professor Peck that "if a piece of lime be rendered incandescent by heating it in an oxo-hydrogen flame, its light, when transmitted through a prism gives a perfectly continous spectrum." Anyone familiar with elementary chemistry would know that lime is carbonate of calcium and not a compound of sodium, while no one familiar with spectrum analysis would expect to get a spectrum of a material from an incandescent solid, all such bodies giving continuous spectra whatever their material. Spectra of the metals can only be obtained from vapors and the spectrum of sodium consists of two yellow lines well known as the "D" lines. Such pieces of careless editing are of course ridiculous to the educated but are exceedingly misleading to many readers of the journals who look to their papers as a means of obtaining knowledge and information for which their education has not been sufficiently extensive.

ELECTRICITY IN THE NEW NAVY.

In the issue of the "Electrical World" for August 16th is an elaborate description of the electric machinery used in operating the various signalling and maneuvering systems of the battleship "Indiana." The article is particularly interesting to engineers as exemplifying the many uses which can be made of the electrical current, from measuring the angle in the Fiske Range Finder, steering the ship by an automatic electric compass, to loading, training, and firing the heavy guns. Indeed the electrical engineering training necessary to keep the apparatus of such a ship in order includes as many details as would be necessary for an engineer controlling the operations of an entire city. While we are compelled to admire the ingenuity displayed in the invention of this apparatus, we are also impelled to wonder at the possible effects on such machinery when receiving the severe shocks incident to a combat. Considering the weight and velocity of a solid shot thrown by one of the high power twelve-inch coast defence guns, we can say that, should the "Indiana" be struck fairly astern, enough energy would be delivered to the ship to propel the vessel at full speed for a distance of four hundred feet, and apart from the possibilities of penetra-

tion and explosion of shells such mechanical shocks would certainly test very severely every piece of delicate mechanism on board the vessel. Indeed, during the late Chinese war one of their ships was several times plunged into complete darkness by a failure of their electric machinery due to the severe shocks received by the vessel, and unless the mechanical details are so well worked out in the vessels of our navy that these delicate machines will withstand the most severe mechanical shocks, our floating fighting machines in time of battle would soon be reduced to floating shelters without offensive power. There is no doubt but that electrical power for manipulation is more easily adapted to the requirements of such a ship than steam or hydraulic power, and the question we would bring up is rather concerning the necessity of the efficiency of the machinery as such. These questions of course can receive no further light until the dreaded test is made and until such a test is made perhaps the ships are serving their purpose by giving employment to men and in offering opportunities for the exercise of ingenuity.

ELECTRO-ECONOMICS IN STATION PRACTICE.

In the English "Electrician" of August 21st, Mr. Arthur Wright of Brighton, England, presents an interesting paper on central station practice in which he shows the law of variation between the cost per unit and the rate of supply in such an undertaking. Carefully analyzing this cost Mr. Wright shows that the cost per unit follows a curve which varies from month to month as the maximum supply of the station rather than the curve of daily average supply, from which it appears that the cost per unit of any electrical supply contains constants depending on the maximum monthly output which are of more importance than the consumption of fuel and the cost of other quantities variable with the continuous output. This indicates that for great economy the central station engineer should determine these constants and apply his ingenuity to reducing their value and not devote himself entirely to the question of coal consumption which at present is so largely considered to the exclusion of all other details. The discussion also shows that the effort to increase the average load to a maximum value is an effort in the right direction and where an engineer is able to bring this about he is also working towards a high efficiency. Such efforts towards economy which involve a corresponding increase in station equipment for the storage of energy have not been attended with a great deal of success, and one would hope to find a future increase of economy from a reduction of the constants we have mentioned rather than along efforts to level out the load line.

INTERNATIONAL BIMETALISM.

Whether or not the efforts to remonetize silver shall eventually prove to be of benefit or harm to the financial situation, there certainly seems to have been no plan proposed for remonetization as comprehensive and business like as that proposed by Richard Rothwell in the "Engineering and Mining Journal" for Dec. 3rd 1892 and recently republished in a pamphlet entitled "International Bimetalism". Mr. Rothwell proceeds as one desirous of preserving the great silver industry and in the first place shows that the manufacturing demand for silver at a price no higher than 20 cents per ounce would be supplied for a long time to come by the the stock at present on hand in the mints of the world and he accordingly concludes that as the mining cost for silver amounts to no less than 68 cents per ounce any attempt to reduce silver to the condition of a material for the arts would be naturally disastrous to the industry. In consequence therefore we are faced by the condition that a great industry exists which can only be made useful by the continued employment of silver as a currency. This conclusion is drawn in the face of his opinion that it would require a long period of depression and financial panic infinitely more intense than any ever yet seen, and many bitter strikes accompanied by struggle and desperation and a general stoppage of the wheels of commerce before the business of the world could be adapted to the new conditions, and men would willingly accept half or one-third of the wages they had been accustomed to." This opinion he makes the basis for an argument, which seems unanswerable, against universal monometallism with gold as the only money as well as against the single adoption by the United States of the free coinage of silver. Furthermore he judges that the unlimited coinage of both gold and silver by all the mints of the world upon a fixed ratio could not prevent a continual variation in the standard of value resulting in alternating monometallism, now of gold and now of silver. In order therefore to solve the vexed problem and preserve in justice and an intelligent consideration for the interests of the human race, he makes a proposal that an international clearing house be established which shall govern the unlimited coinage of gold and silver upon a ratio occasionally variable with the variations in the money values of the metals. That such a system would not result in excessive fluctuations in the values of the coins he shows by a comparison of the value ratios of gold and silver and the world's producing ratios from A. D., 1500 up to the present time; the first remaining nearly constant in spite of the tremendous fluctuations in the latter.

No man in the country has the interest of the silver producer more at heart than has Mr. Rothwell, and few are more capable of speaking concerning our mineral industries and business interests than this man; we must therefore receive his conclusions with due respect and carefully weigh his results. If there is a fallacy in his reasoning it seems rather to lie in the increasing disuse of coin rather than in any impracti-

cability of his plan for universal bimetallism at the present time only between 5 per cent or 10 per cent of this country's business involves the use of coin and should we have the introduction of a universal clearing house, international credit transfers would be increased and international coin transfers diminished. Furthermore, any such wide extension of the clearing house principle might work down as well as up and the use of coin in small transactions be diminished by the establishment of many local and interstate clearing houses handling small debts and credits as an international clearing house would handle public accounts, resulting in an extension of the principle of barter and a vast diminution of the demands for coin in all lands. Whether the countries of the world must take account of the existence of a great mineral industry and strive to maintain its importance, or whether the mineral industries must recognize the changed position of the metals as money, remains for future solution, though we must grant that one or both of these conditions are demanding to be met and the present financial operations to be revolutionized.

A MAMMOTH WATER-WHEEL.

The Pelton Water-Wheel Company has recently furnished the Alaska Gold Mining Company, of Douglass Island, Alaska, a wheel of such extraordinary dimensions as to make a brief description of interest.

The wheel is 22 feet in diameter and is direct connected to the shaft of a Reidler Duplex Compressor, with air cylinders 24 in. in diameter x 38 in. stroke, having a capacity of delivering 2,800 cubic feet of free air per minute at a pressure of 80 lbs. per square inch. The wheel weighs 25,000 pounds, and serves the purpose of a fly wheel as well as prime mover. It runs under a water head of 480 feet at a speed of 75 revolutions and develops upward of 500 h. p. A hydraulic speed regulator is attached to the wheel, which controls its movement so that a uniform air pressure is maintained on the receiver. The wheel is made of this large diameter to give proper speed to the compressor under the head in this case available.

This is probably the largest tangential wheel ever constructed and shows the remarkable facility with which Pelton wheels can be adapted to unusual and extraordinary conditions. In a case like this the transmission machinery to carry such an amount of power would involve a heavy out-lay as well as constant expense in maintenance, besides a material loss of power; a direct connection to water wheel of machinery operated without intermediate gearing is, therefore, of great advantage wherever possible.

Mr. S. Z. Witchall, Manager of the Portland, Or., office of the General Electric Company, was a recent welcome visitor to San Francisco.

THE SMITH-MANIFOLD CALCULATOR.

BY GEO. P LOW.

The convenience of the slide rule as a time and labor-saving device has long been appreciated by all branches of engineering professions, and considering the wonderful facility with which intricate problems are solved thereby it is little short of astounding that the appliance has not come into universal use by every one who has aught to do with mathematical calculations, regardless of whether the problem to be solved consists of simply multiplication or division, of proportion, of calculations embodying logarithmic functions, of the conversion of units of measure, of geometrical or trigonometrical functions, or in brief, of effecting the solution at a glance of any problem based on the fundamental principles of proportion. The Brown & Sharp gauge for measuring wires is essentially a purely scientific one in that under it the dimensions of wires advance in geometrical progression, and in this connection it is interesting to review a portion of one of a series of articles by Frederic A. C. Perrine, D. Sc. on "The Manufacture of Wire" now running in Electrical Engineering, in which the author points out that "The sizes of different conductors may be distinguished by reference either to the measurement of their diameters expressed in mils, in fractions of an inch, or in millimeters, but the custom of wire manufacturers has rendered the distinction of wire sizes by reference to certain gauge numbers much more common. These gauge numbers are all more or less arbitrary and are a relic of the time when the correct measurement of a wire diameter was not readily made and when wire drawing was performed with great lack of uniformity. In order to compare various wires recourse was had to gauges of different forms upon which numbers were stamped corresponding to different sizes determined arbitrarily, and as the business has been developed the old gauge numbers have been expressed in decimals of an inch or in millimeters, and certain new gauge numbers have been adopted in which the variation in sizes of the different wires follow particular laws. The gauges above referred to were, in the earliest practice, plates of metal through which holes had been bored corresponding to the different sizes of wires. Many disadvantages attach themselves to this method of gauging. In the first place, it is necessary to square the end of the wire before determining its size; secondly, any irregularities in cutting off the wire would lead to false results in gauging, and finally it is impossible to tell whether the wire is closely or only roughly a fit into its particular hole. The first advance upon this method was made by the introduction of a gauge formed of a circular plate of metal with slots corresponding to the different gauge numbers sawn into its edge. This gauge was capable of being

used upon any part of the wire and of determining with greater accuracy the variation of the wire from its true gauge number.

"In about 1850 a new gauge was introduced which gave not only the gauge number, but with a reasonable approximation the variation of any particular wire from its gauge number. This gauge consisted of two straight edges of metal clamped together in such a manner that an open "V" was inclosed by their straight edges, and along the sides of one or both of these edges straight lines were stamped corresponding to the different gauge numbers. In use the wire of which one wished to determine the size was slipped into the "V" until it firmly touched both sides, when the nearest line would determine its size, and the distance from that line would determine the variation from the true gauge number. Although these different gauges have been manufactured from time to time most carefully of hardened steel and ground with great accuracy they were subject to variations in size produced by changes of temperature, and were especially liable to wear when frequently used upon a particular size of wire, thus introducing considerable confusion when wires were ordered to correspond to one instrument and manufactured from another, though both may have been identical when they were originally constructed. In consequence change has been proved throughout its continued use, especially for the users of electrical conductors, in which service the carrying capacity of the wire varying as the area is the most important point to be determined. A new gauge is now adopted as the standard in England and is called the English legal standard or Imperial wire gauge. This gauge differs from the American, or B. & S. gauge, in not determining the gauge numbers from areas, but in merely being a correction of the Birmingham gauge in such a manner that the variation in the size of the various numbers proceeds uniformly.

"Of recent attempts to change the system of numbering wire gauges the most notable is that adopted some years ago by the Edison Company, in which the gauge numbers refer to the areas of the wires in circular mils, the different numbers representing even thousands of circular mils; the system embodying very considerable advantages with the sole disadvantage that its identification with one company has hindered its general introduction. At the present time there seems to be no reason for desiring any change from the common system used in the determination of wire sizes unless it would be possible to eliminate altogether the Birmingham wire gauge from use and to introduce in this country both for iron and copper wires the more rational American gauge which is the standard for the users of electrical conductors who are by far the largest purchasers of wire at the present time. This wire gauge begins with No. 0000, having a size of 460 mils, and ends with No. 40, 3.14 mils in diameter. Larger conductors than this No. 0000, as we have already said, cannot readily be manufactured or handled, and in consequence the sizes of conductors with a greater area are generally expressed by their areas in circular mils and are almost always built up of smaller wires twisted into the form of a strand. In order to determine the size of the wire for forming any strand of a particular number of wires it is necessary only to divide the area of the strand by the number of wires, which will give the area of the constituent wires of the strand in circular mils, and the extraction of the square root will determine the diameter of the wires in mils; and conversely, the area of a strand in circular mils may be found by multiplying the square of the diameter of its constituent wires, expressed in mils, by the number of wires in the strand."

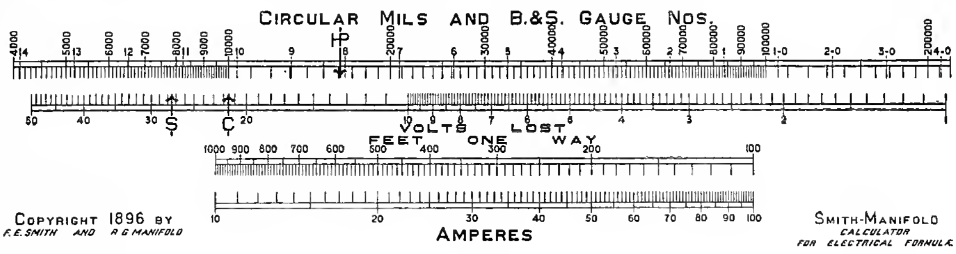

FIGURE 1.—THE SMITH-MANIFOLD CALCULATOR.

With these preliminary remarks on wire gauges it is well to proceed to the consideration of the Smith-Manifold Slide Rule Calculator for electrical formulae, which, as appears from the accompanying illustrations, is merely a slide rule on which is set off the characteristics pertaining to the area of the various sizes of wires in the Brown & Sharp gauge from No. 14 to No. 0000, together with the functions of an electric circuit as based upon Ohm's law. To faciliate an understanding of the slide rule in Figure 1 is presented an outline of the Smith-Manifold Calculator (copyrighted 1896 by F. E. Smith and R. G. Manifold) in which the scales are set apart that there may be no confusion between them to the beginner. For convenience, these scales are designated respectively by the terms, Scales A, B, C and D, as follows:

Scale A, Circular Mils and B. & S. Gauge numbers.
Scale B, Volts lost.
Scale C, Feet one way.
Scale D, Amperes.

As is well known, the slide rule consists of a rigid

backing of card board, wood or celluloid, firmly secured to which are scales A and D (Figure 1) into grooves on the inner sides of which slides a second rule bearing scales B and C and the manipulation of the calculator merely consists in moving the slide bearing the scales B and C until a given factor on scale C for instance is set opposite a given factor on scale D when the quantities appearing opposite each other on scales A and B will show the results arising from the assumed condition. A simple example will illustrate clearly the mode of using the slide rule calculator:

First example: It is desired to transmit 50 amperes a distance of 400 feet with a loss of 2 volts; required, the size of the conductor.

Before proceeding to a solution of the problem it should be observed that the Smith-Manifold Calculator contains the factors that are common to every problem that may arise in the determination of characteristics of direct currents and these factors are fundamental in that they are represented in volts, amperes and Ohms (feet) rather than in percentages of loss and lamps. Bearing this in mind, and referring again

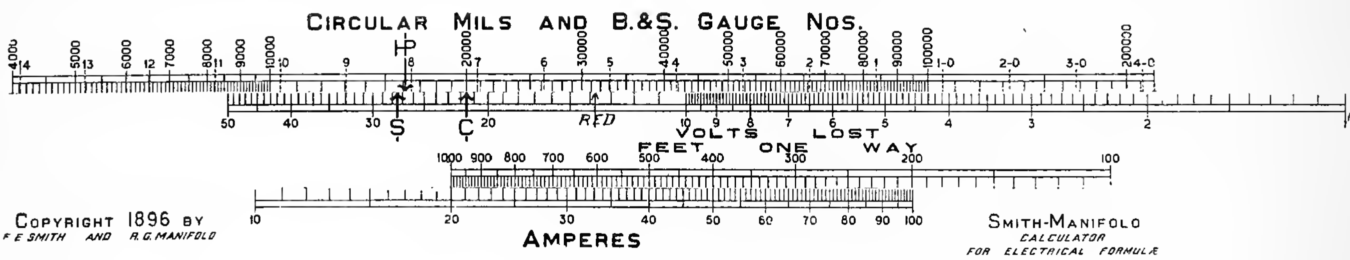

Figure 2.—The Smith Manifold Calculator.

to the problem above, on scale C find the unit marking 400 feet, which line is to be set opposite the 50-ampere line appearing on scale D. This is a simple process consisting merely of drawing out the slide containing scales B and C until the 400-foot mark is opposite the 50-ampere mark as shown fully in Figure 2. Now look along scale B and find the line marking 2 volts loss opposite which on scale A it appears that the required size of wire a trifle above No. 0000; to be more exact, and to express the required sizes of wire in precise circular milage it will be seen that the two volt loss mark is a trifle above the center of the division between 210,000 circular mils and 220,000 circular mils, hence the required size of the wire is 216,000 circular mils, or practically a No. 0000 B. and S. wire.

Following the same lines of procedure and with the same setting of the rule it will be seen at a glance that with

3 Volts.	Loss.	Size of Conductor required is........143,000 C. M.
4 "	"	" " " ....108,000 " "
5 "	"	" " " .... 87,000 " "
6 "	"	" " " .... 72,000 " "
7 "	"	" " " .... 62,000 " "
8 "	"	" " " .... 54.300 " "
9 "	"	" " " .... 48,300 " "
10 "	"	" " " .... 43,200 " "

The manipulation of the Smith-Manifold Calculator is merely one of practice and of following the equally simple rules as that exemplified in the solution of the above problem. In order to show more fully, however, the completeness of the calculator as a pocket compendium including tables for the determination of the weights, dimensions and properties of wires in addition to the calculation of their functions the following partial list of the problems readily solved thereby is given, and in the ensuing articles of this series will be presented instructions for the manipulation of the calculator in each and every instance.

OHM'S LAW.

1. Given resistance and voltage to find amperes.
2. Given volts and amperes to find resistance.
3. Given resistance and amperes to find volts.

ELECTRIC POWER.

4. Given amperes and volts to find the horse-power.
5. Given horse-power and volts to find the amperes
6. Given horse-power and amperes to find the volts.

WIRE TABLES.

7. Given the size of wire to find its carrying capacity at 2,000 amperes per square inch.
8. Given the size of wire to find its carrying capacity at 1,000 amperes per square inch.
9. To reduce circular mils to square mils.
10. To reduce square mils to circular mils.
11. Given the circular mils to find the diameter.
12. Given the diameter to find the circular mils.
13. Given the diameter to find the square mils.
14. Given the square mils to find the diameter.
15. To find equivalent sizes of wire.
16. Given the size and number of strands in a cable to find its circular mils.
17. Given the size of wire to find its weight per 1,000 feet.
18. Given the size of wire to find its resistance per 1,000 feet.
19. Given the size of wire to find its weight per mile.
20. Given the size of wire to find its resistance per mile.
21. Given the weight per 1,000 feet to find the size.
22. Given the size to find the feet per Ohm.
23 Given the size to find the feet per lb., etc., etc.

WIRING FORMULAE.

24. Given the amperes, distance and volts lost to find the size of wire.

25. Given the amperes, distance and size of wire to find the volts lost.

26. Given the amperes, volts lost and size of wire to find the distance.

27. Given the distance, volts lost and size of wire to find the amperes.

HYDRAULICS.

28. Given the cubic feet of water per minute, the head in feet, and the water wheel efficiency to find the horse-power.

29. Given the head, the horse-power and the efficiency to find the cubic feet of water required.

30. Given the horse-power, efficiency and cubic feet of water available to find the head required.

31. Given the horse-power, head and cubic feet of water to find the efficiency.

32. Given the miners inches of water, the head in feet and the water wheel efficiency to find the horse-power.

33. Given the head, the horse-power and the efficiency to find the miners inches required.

34. Given the horse-power, efficiency and miners inches available to find the head required.

35. Given the horse-power, head and miners inches of water to find the efficiency.

(To be continued.)

THE PUBLIC AND "THE INFANT SCIENCE."

BY DONALD H. FRY.

It may be a matter of interest to the readers of the "Journal" to know how exceedingly ignorant the public is on matters pertaining to machinery and electricity. At the recent Mechanics Fair, held in San Francisco, the questions asked and remarks made about the Union Iron Work's exhibit—a vertical compound engine direct connected to a Siemens and Halske dynamo—will serve to illustrate how well the average man is versed in electrical matters. The inquiries given below are given verbatim:

The following one-sided conversation which took place between a well dressed gentleman—evidently a professional man—and the lady he was escorting, gave the attendant the idea of taking notes of some of the remarks made.

"An electrical machine?" he asked the attendant in a manner calculated to impress the lady with his knowledge rather than that he asked for information. Then turning to the lady, "You see the electricity is formed by the friction of those copper bars,—technically termed brushes—pressing on that large copper ring, which is called a commutation ring."

"What is that shiny stuff?" asked the lady pointing to the revolving spider.

"Oh, that is composed of electric wires which protrude from each of the segments thereby forming circuits for the electrical currents to pass through."

"Oh, I see," said the lady with child-like credulity.

Here are a few samples of the many questions asked:

"Is that the Union Crushing machine?"

"Is it a quartz machine?"

"Are you polishing that metal?" pointing to the commutator.

"Where do you get the power from?"

"Do they (the dynamo and engine) run well together?"

"Are those things (indicating the cross-heads) electrical pumps?"

"Does that dynamo run the engine?"

"That's a marine engine, isn't it?" I suppose that is why they call it Siemen's system.'"

"Which is the engine and which is the dynamo?"

"Are those things (brushes) brakes?"

"Is it water or steam you use in that thing? (cylinders). Don't you use water? I thought that you had to use water when making electricity to make it cool quicker."

"Now, young man, I have studied electricity quite extremely myself, but there is one thing that sticks me,—how does the electricity get to the lamps after you have made it? Does it run along the wires?"

"Couldn't you get enough power out of that dynamo to run a steam engine?"

"How many volts does it make a minute? How many cars would it pull?"

"That machine runs on ball bearings, doesn't it? Now, I can't understand how that inside stands still and the outside runs on the ball-bearings."

And then the authors of these bright remarks usually went away observing: "Electricity is a great thing. Has an unlimited field, but it is still in its infancy."

Two old countrymen with long flowing whiskers and "high-water" pants afforded some amusement. After gazing at the machine for some time one ventured to ask, "Now, young man, can you tell me what material makes electricity—same as fuel makes fire? If there is any secret about this machine, of course I don't want to know it, but if you don't mind telling me, why I should like to know. That wooded box—(the cylinders and steam chest were encased in wood)—I suppose is full of acids and copper and zinc and things. Isn't it?" While the attendant was gasping for breath the second old man came to the rescue with:—

"I though ma'be that it went so fast that it created its own combustibles. A very little of your electric stuff would do the work,—she is pretty big and she is going blamed fast, by gum!"

This morning a conductor on a University car nearly died with heart disease when a woman stepped off his car at the corner of First and Spring streets like a man, instead of getting off with her face turned toward the rear platform. The conductor was taken to the Receiving Hospital. The doctors are under the impression that the shock was too great, even for a conductor to stand.—Los Angeles Herald.

Transportation

SAN DIEGO, CAL.—The San Diego Electric Railway Company, in connection with the Southern California Mountain Water Company, has submitted a proposition to the city to furnish water and sprinkle certain streets at one-half the present cost, and if the proposition is accepted either salt or fresh water will be used. The plan includes the laying of a 10-inch main from the power house up "D" street to Seventh, thence north to Ash street, where a 250,000-gallon steel reservoir will be erected at an elevation of 160 feet, from which will be laid distributing mains for salt water.

LOS ANGELES, CAL.—The Pasadena & Pacific Electric Railway system extends from Altadena to South Santa Monica, a distance of a fraction over thirty-five miles. This is believed to be the longest electric railway in the United States. ——The Board of Fire Commissioners has granted Witmer Brothers permission to operate an electric power plant in the Second street power house.——The erection of the new 1000 h. p. engine to operate the 800 k. w. Walker generator, being installed in the Los Angeles Railway Company's power house, is being completed.——Ten new double-end cars have been added to the equipment of the railway company.——Three new 500 h. p. boilers are being installed in the railway power house.

LOS ANGELES, CAL.—The general offices of the Los Angeles Railway Company have been removed from the Central avenue power house, thereby increasing the engine-room nearly one-half. The present steam equipment consists of one 1000 h. p., two 600 h. p. and one 250 h. p. engines, driving various Westinghouse and Edison generators, and also a Walker 800 k. w. generator.——The Westinghouse Company has sold twenty-eight single and seven double "12A" equipments for use in this city.——Work is progressing rapidly on the new and permanent power house for the Los Angeles and Santa Monica Electric Road at Sherman.——The Traction Company is making a double track extension westerly from the present terminus at Vermont avenue. The new track will run out Vine street, thence west to Rosedale street, south to Adams, west to Western avenue and south on Western avenue to Jefferson street. It is thought that it is the intention to extend the road to Redondo, or possibly Santa Monica.——It is believed that the Main street line will be extended to the University.

CITY OF MEXICO, MEXICO.—The Federated Street Railway system was formally turned over to the new company on August 18th. Thomas H. McLean is President and General Manager, and the general offices will continue to be located at Santa Clara, No. 12.——Modern Mexico has the following to say regarding the transfer: "The purchase of the street railway system of the City of Mexico by American capitalists comprises the sole right-of-way of the desirable streets of the city, together with the following mileage and equipment: One hundred miles of broad-guage track, 60 miles of narrow-guage track, 5 locomotives, 300 passenger cars, 80 freight cars (with privilege of carrying all classes of freight), 40 carts, 2600 mules and horses and 30 funeral cars. The number of passengers carried in 1895 was 17,480,425, at fares ranging from 6 to 31 cents per passenger; number of employees at present, 2100. The parent road has always paid a dividend of from 6 to 7 per cent. since organization, besides putting aside sufficient surplus out of its earnings to enable it to purchase all competing lines, except one small and undesirable single-track road of about four miles in length. The first buyer was Channing F. Meek, of New York, who sold the lines to Henry A. Butters, of San Francisco, Cal. The transaction, including the contemplated re-equipment and improvement of the lines, will involve about $20,000,000 (silver), but the actual purchase price is stated at $7,750,000."

TABLE OF CONTENTS

Abbreviations: Illustrated (*): Editorial, (Ed.): Educational, (Educ.): Electro-Economics, (Elec-Econ.): Electro-Insurance, (Elec-Ins.): Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.): Metallurgy, (Met.); Mining, (Mi.): Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.): Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.): Transportation, (Transp.)

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The Smith-Manifold Calculator

BY GEO. P. LOW.——Part II.

Most interesting and diversified are the uses to which the Smith-Manifold Calculator may be adapted, for in addition to the comprehensive list of problems previously given as being solved by it with the utmost facility, new applications for it come to the user almost daily. The mastering of its simple principles, or more particularly the practice that comes with persever nce

C, the "feet one way" scale, to represent volts, while the amperes are read on the ampere scale. Draw the slide to the left until 230 volts rests on 30.2 amperes. then under 600, on scale D, appears 11.6, which is the

No matter what may be the factors of the energy that the wattmeter is measuring, the number of revolutions will always appear under the 600 mark on

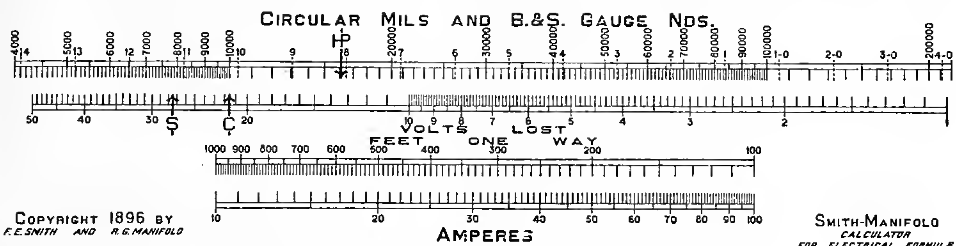


FIGURE 1—THE SMITH-MANIFOLD CALCULATOR

many other quaint yet most satisfactory uses. For instance:

in its use, gives rise to new ideas, each of which expands the sphere of usefulness of the Calculator. Not only is it indispensible as the perfection of wiring tables, formulae, and characteristics, and of hydraulic and electric power calculations, but it may be put to

the "Feet one way" scale, or scale C. Again,

Third example: A Thompson recording wattmeter with a constant of 1, takes 40 amperes from a 500-volt railway circuit; required the number of revolutions per minute the wattmeter disc should make.

Proceed as before, and as shown in Figure 2, the wattmeter disc should make 33 1-3 revolutions per

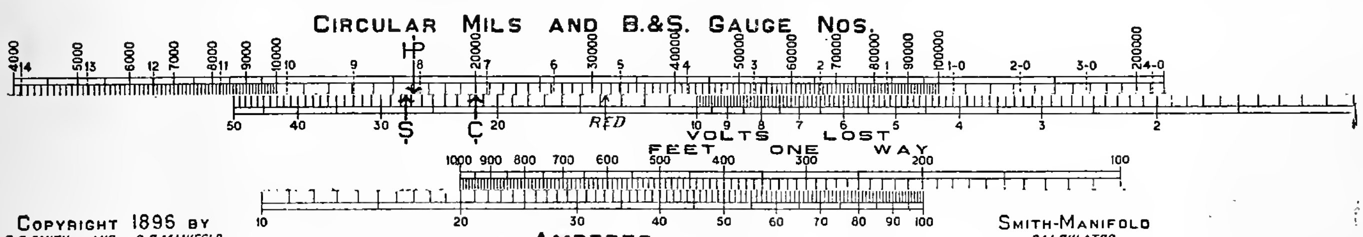


FIGURE 2—THE SMITH-MANIFOLD CALCULATOR

Second example: A Thomson recording wattmeter having a constant of 1, and is measuring 30.2 amperes at 230 volts, required the number of revolutions per minute that the disc should make.

In solving the problem the Calculator is placed as number of revolutions required.

shown in Figure 3; that is, assume the figures on scale

minute, for 33 1-3 appears under 600. Conversely,

Fourth example: A two wire wattmeter is cut in on a service supplying a certain consumer, and it is desired to know the current consumption, the potential of the service being known.

If the latter is, say, 110 volts, and the meter makes 16 3-5 revolutions per minute, proceed practically as

in the two preceding examples, or in other words, adjust the slide of the Calculator, so that the mark for 16 2-3 (revolutions) appears directly under the 600 mark on scale C. It so happens in this case that the position to be found is the normal one of the Calculator as in Figure 1. Now under 110 (volts) on scale C, read 91 amperes, which is the current the wattmeter is measuring.

Clearly then, it is far more easy to look at a Smith-Manifold Calculator and read the ampereage therefrom after merely counting the number of revolutions the wattmeter disc is making than to go to the station for the Weston ammeter, to rig up a jumper so as not to interrupt the service, to cut in the ammeter, to take the reading and then undo all that has been done. If alternating current service is delivered, the leveling and calculation attending the use of a Siemens dynamometer will make one's misery complete, but he will have gotten the ampereage within an hour

1 volt loss the conductor must have an area of more than 200,000 circular mils—how much more is not shown. It was seen in the first example that a wire of 216,000 circular mils was required to give 2 volts loss, hence clearly, to give one volt loss the area of the conductor must be twice as much or 432,000 circular mils. The second mode is more accurate solely because of the greater legibility of Scale A for sizes below 100,000 circular mils and in this instance the mode consists of finding the size of wire necessary to give a loss of 10 volts and then multiplying the circular milage thus derived by 10. Use the same setting of the Scale and over the mark indicating a loss of 10 volts, it will be seen that for that drop a wire having an area of 43,200 circular mils must be used, hence for 1 volt loss its area must be ten times as great or 432,000 circular mils. Suppose now, another case is presented shown in the:

Sixth example: A loss of 2 volts is permitted on

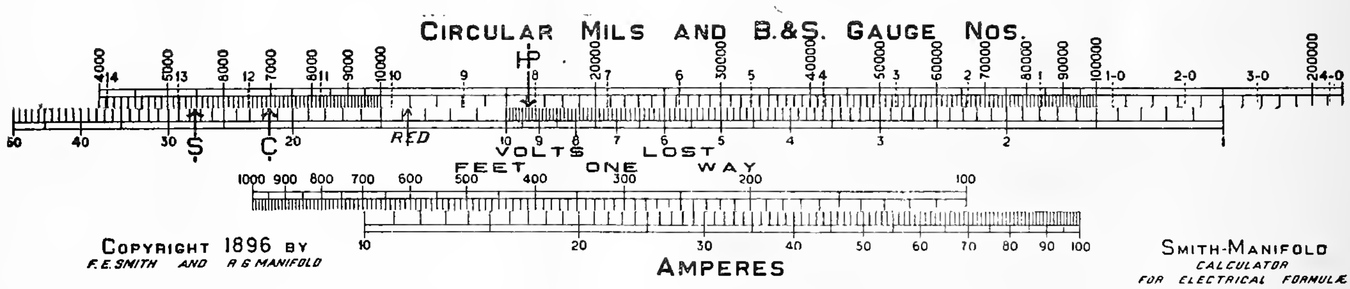


FIGURE 3—THE SMITH-MANIFOLD CALCULATOR

and a half even though the calculator will have given it in a minute and a half.

It will appear at the outset that the Calculator in itself is limited from 4,000 circular mils to 200,000 circular mils; from 1 to 50 volts loss; from 100 to 1,000 feet one way and from 10 to 100 amperes, but this is an apparent and not a real limitation in that whatever may be the problem, the Calculator will solve it in the manner to be shown. Following up the first example, it was found that to deliver 50 amperes a distance of 400 feet with 2 volts loss, required a conductor of 216,000 circular mils. From this advance to the:

Fifth example: Required the size of conductor to deliver 50 amperes a distance of 400 feet with a loss of 1 volt.

There are two different yet simple modes of solving the problem, in both of which the Calculator is set as in Figure 2. It is obvious that the size of wire required for volt loss must be twice that for two volts loss or ten times that for a loss of 10 volts. Apparently the result is not given directly on the Calculator for the reason that it is found upon inspection that with

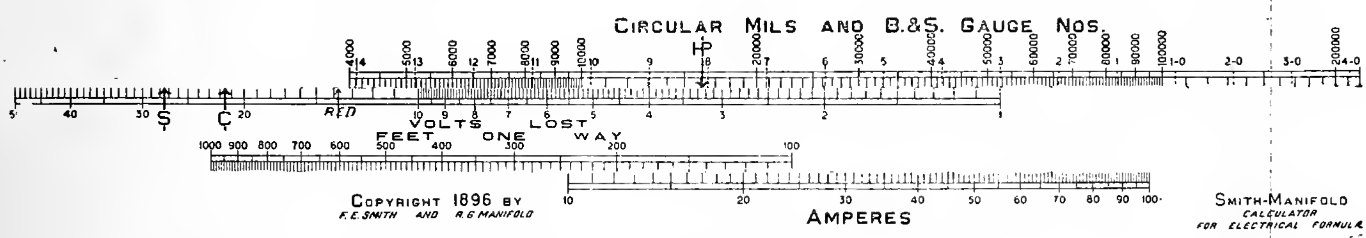
a lighting circuit carrying 5 amperes a distance of 400 feet; required the size of conductor?

The same method of reasoning is to be adhered to as was worked out in the preceding example, hence assume as before that the current is 50 (10 times 5) amperes, in which event the Calculator is placed as in Figure 2, and the required area of 216,000 circular mils is again shown, but as 5 amperes and not 50 amperes are transmitted, the cipher added under the assumption must be dropped which shows the size of the conductor necessary to carry 5 amperes 400 feet with a loss of 2 volts, to be 21,600 circular mils. Had the drop been 1 volt, 43,200 circular mils of conductor would have been necessary, or had the permissable loss in voltage been but one half a volt, 86,400 circular mils would have been necessary.

In brief, (1) add to the circular mils scale one cipher for each cipher assumed to be added to either factor appearing on the "feet one way" or the ampere scales; (2) drop from the circular mils scale one cipher for each cipher assumed to be dropped from either factor appearing on the "feet one way" or the ampere scales;

(3) add to or deduct from the number of ciphers given on the circular mils scale, as many ciphers as appear in the difference between the ciphers assumed to be added to or deducted from the "feet one way" and ampere scale, and finally bear in mind that (4) while the volts lost vary directly as the amperes carried and the distance (feet-one-way) traversed, they vary inversely as the circular milage or area of the conductor. To be still more explicit, the larger the amperage, or the greater the distance, or both, the greater will be the loss or drop in volts over a given size of wire, in direct proportion to the increase of either or both factors, but the greater the circular milage the less will be the loss in volts with a given distance and amperage.

A clear understanding of that which has been explained will be had from a study of the following schedule of miscellaneous wiring problems readily solved by setting the Calculator per Figure 2:



THE FIGURE 4—SMITH-MANIFOLD CALCULATOR

50 amperes,		400 ft., 2 volts loss,	216,000 C. M.	
50	"	40 ft., 2 volts loss,	21,600 C. M.	(2)
50	"	4 ft., 2 volts loss,	2,160 C. M.	(2)
50	"	4,000 ft., 2 volts loss,	2,160,000 C. M.	(1)
50	"	4,000 ft., 1 volt loss,	4,320,000 C. M.	(1) (4)
5	"	4,000 ft., 1 volt loss,	432,000 C. M.	(3)
5	"	400 ft., 2 volts loss,	21,600 C. M.	(2)
5	"	400 ft., 1 volt loss,	43,200 C. M.	(2) (4)
5	"	40 ft., 1 volt loss,	4,320 C. M.	(2) (4)
5	"	40 ft., 2 volts loss,	2,160 C. M.	(2)
500	"	400 ft., 2 volts loss,	2,160,000 C. M.	(1)
500	"	40 ft., 2 volts loss,	216,000 C. M.	(3)
500	"	40 ft., 1 volt loss,	432,000 C. M.	(3)

etc., etc., etc.

(To be continued.)

COMMENDS IT HIGHLY.

The success which the General Electric Company's long burning arc lamps is meeting from all sides is shown by the steady increase in the orders. In a recent letter from the Superintendent of an important station in Maine is the following: "We have used the lamps for eight months with exceedingly gratifying results. Our customers are as well pleased as we, as increasing orders for them testify. We can commend this lamp most highly to electric companies wishing a lever against gas, and in places where the ordinary arc or incandescents cannot be installed."

THE STEVENS INSTITUTE OF TECHNOLOGY.

A noteworthy event in the annals of technical education in the United States will be the forthcoming celebration of the 25th anniversary of the Stevens Institute of Technology, on the 18th and 19th of Febuary next. The festivities will consist of a banquet, at the Hotel Waldorf, New York, to which representative engineers and technical educators throughout the country will be invited. On the following day the Institute will be open for inspection, and the methods of instruction, together with the apparatus in the various laboratories will be explained. Not the least interesting feature of the exhibition will be the collection illustrating the work of the Alumni, and consisting of machinery, apparatus, drawings, etc., representing the product of their activity during the 25 years. The festivities also include a reception, tendered to the faculty, graduates and undergraduates, by Mrs. E. A. Stevens, widow of the founder of the Institute, at Castle Point, Hoboken; a Promenade Concert and Dance in the evening will conclude the celebration.

The Institute has always taken high rank by the late Edwin A. Stevens of Hoboken, N. J., and in 1870 the erection of a building was commenced by the trustees, Mrs. E. A. Stevens, Mr. S. Bayard Dod, and Mr. W. W. Shippen. Dr. Henry Morton, at that time Secretary of the Franklin Institute of Phildelphia, was tendered the presidency of the Institute, and gathered a faculty of eight members about him. To this number others have from time to time been added, as the work of the Institute increased, until at the present time the faculty includes twenty-two professors and instructors. The total number of student graduates is 675, and the number in attendance during recent years has been about 260 each year.

The Stevens Institute has always taken high rank among the institutions devoted to technical education in the United States, and its 25 years of successful effort is amply exemplified in the work accomplished by its graduates in all departments of mechanical and electrical engineering.

Hydraulics

OVERCOMING WATER SHOCK.

Probably no more serious difficulty than that known as water ramming or water shock has stood in the way of the perfect application of water power to high heads of water and the difficulties directly due thereto are manifested in the tremendous strain to which the pipe line is sometimes subjected and to the marked increase in pressure which naturally accompanies the checking or stopping of water flow in a pipe line. It is the latter which is the cause of the trouble that has been experienced heretofore in devising a governor for giving such control of water delivered to a wheel as will insure the delivery of a constant speed, but the governing of water wheels is now an accomplished fact, regardless of the conditions which exist, and as the difficulties which have been met in the use of water under high heads as a motive power, are of two forms as above outlined, there remains but the one of overcoming water shock to be surmounted.

FIGURE 1—A BREAK DUE TO WATER SHOCK

The phenomena of ram or shock in pipe lines has been observed by all and many devices have been suggested for effecting a protection for the pipe against bursting or other serious injuries, but so far none have been applicable to all conditions and few have been effective under any conditions. How serious the consequences attending ramming may be is well shown in the accompanying engraving (Fig. 1) from a portion of a 22-inch pipe line conveying water under high head and which, owing to inexcusable carelessness on the part of an employe in instantly closing the wheel-gate, burst in the manner shown. The walls of this pipe are of quarter-inch rolled steel and the aperture made in the broken pipe had the maximum dimensions of 16 inches by 22 inches. The characteristics of the break together with the manner in which it was repaired are clearly shown in the engraving, but the damage wrought was rendered greater by the collapse of fifteen lengths of wrought iron pipe from atmospheric shock. This wrought iron pipe was in the upper end of the pipe line considerably above the point where the actual break occured and at first thought it may appear singular to the layman that pipe which successfully withstands a water pressure of several hundred pounds should be broken or rather, crushed, by the atmospheric pressnre of 15 pounds per square inch. It should be stated, however, that this atmospheric shock was due to the fact that when the break occured the weight of the column of water in the pipe line above it caused the water to rush out through the break at a far greater velocity than it was possible for the water to enter the intake at the head of the pipe line, thus causing the vacuum to be formed in the pipe line which, though capable of withstanding an internal pressure of several hundred pounds, is not by reason of its construction of sufficient rigidity to withstand the low external atmospheric pressure—being of 7 pounds per square inch,—as developed by a vacuum within the pipe.

The illustration presented is that of an extreme case which, though an actual occurrence, carries with it an idea of the one remaining difficulty attending the use of water under high head. It can not be said that experience has demonstrated the success of relief valves as a means of preventing the evils of water shock. Greater success has been attended by the application of an air chamber of suitable dimensions and such chamber gives to a pipe line an elasticity to resist shock which is not obtainable with any other known device and so far as receiving and absorbing the shock

per se is concerned, probably no better device will be forthcoming.

But where the flow of water in the pipe line is used to drive water wheels and when the quantity of flow is regulated by increasing or diminishing the area of cross section of the nozzle, the use of an air chamber has presented some difficulty.

Messrs. Cobb & Hesselmeyer, mechanical and hydraulic engineers of San Francisco and who have brought out a new device for preventing fluctuations of pressure due to water shock, point out some of the difficulties attending the use of an air chamber under the conditions given. In illustrating the case, they consider a pipe line flowing full of water at a normal velocity under a given pressure and discharging through an orifice of variable cross-section. It is assumed that

cause coincident increase and decrease of velocity of flow at the discharge orifice, and render the attainment of uniform speed in the water wheel a matter of uncertainity.

The water which enters the air chamber during the compression of the air therein is discharged through a suitable waste valve at the side, this valve being opened by the excess of pressure above normal as entrapped in the air chamber, and closes automatically when the water discharging from the air chamber has reduced the pressure therein down to normal conditions.

It will be observed that under this arrangement:—first, only that amount of water is wasted which is passed through the air chamber as an exact measure of the energy of the rams overcome.

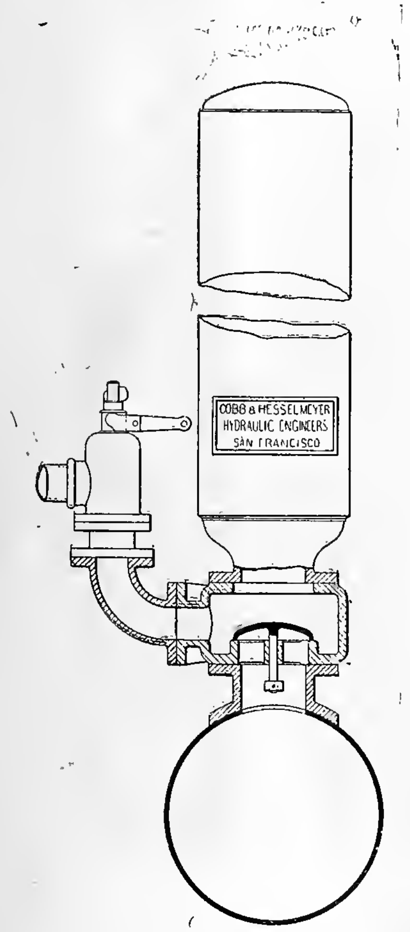


FIGURE 2—RELIEVING THE REBOUND OF AN AIR CHAMBER.

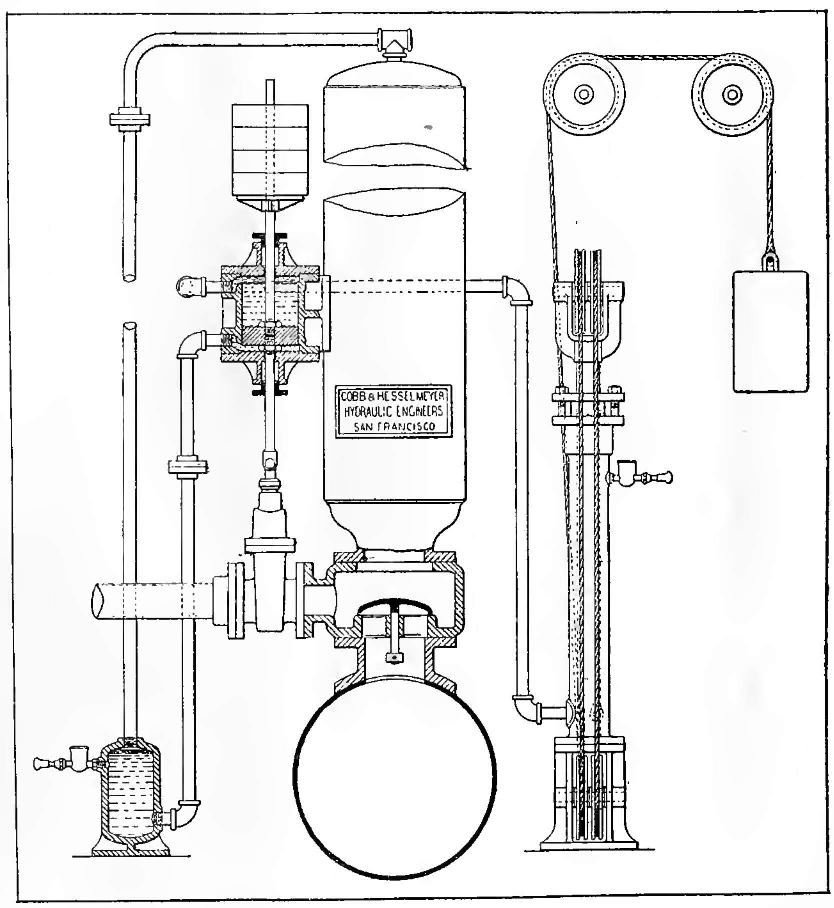


FIGURE 3—ARRANGEMENT FOR AN EXCEPTIONALLY CLOSE REGULATION

this pipe line is provided with an air chamber placed at a point preferably near the point of discharge; suppose that the cross-section of the discharge orifice be suddenly decreased, then the normal velocity of flow in the pipe line must be as suddenly checked, and the excess energy of the moving mass will be spent in, first: compressing to a greater degree the air confined in the air chamber; and, second; in giving an increased velocity of flow through the reduced discharge area.

The air in the air chamber thus compressed above its normal pressure will react and cause a return flow or rebound of water in the pipe line, the energy of which will be as great as the original excess energy of flow, less the loss due to friction, and this alternate flow and rebound will continue in action until friction has absorbed the excess energy of the moving mass. The alternate flow and rebound above referred to,

Second, that under normal conditions, the pressures the automatic stop valve between air chamber and pipe is in balance.

Third, that in most situations, the simple arrangement shown in Figure 2 may be used, as the confined, non-fluctuating, excess pressure in the air-chamber is an ideal medium to operate a safety valve as there shown.

Fourth, that if an exceptionally close regulation of pressure in the pipe line is desired, the arrangement shown in Figure 3 may be used, wherein the discharge valve from the air chamber is operated by an hydraulic cylinder, the piston of which receives on one of its faces the pressure of the air-chamber, and on its opposite face a constant pressure from the accumulator shown, exactly equal to the normal working pressure of the pipe line.

Electro-Therapeuty

HOW AND WHY X-RAYS BURN.

In pointing out the serious effects of over-exposure to Roentgen rays, Dr. Philip Mills Jones states through a contribution to the San Francisco Examiner, that when Professor Roentgen announced his discovery, the fact that the bones of the skeleton could be examined without removing the coverings of skin and muscle was sufficiently startling to awaken universal interest—markedly so in the case of medical men.

As the apparatus used became better understood and improvements were made, reports came from different parts of the country of various casualties following upon exposure to the action of the new radiation.

Proceeding to a description of the symptoms and development of the malady, Dr. Jones states that in from twenty four hours to seven days after exposure to a vacuum tube from which are proceeding X-rays the skin on the area exposed may commence to be somewhat inflamed; it feels hot and itches; then the burning sensation becomes intense, the skin puffs up and is very sensitive—sometimes it turns almost black; later the hair falls out, and in the case of the hand the nails become very red and sore, and finally are cast off. If the skin is scratched or struck while in the second, or puffy stage blisters followed by suppuration ensue. The process slowly subsides, the skin becomes dry, scaly and peels off, leaving a new healthy skin beneath. This inflammation has been named "Dermatitis Roentgenii," and is a true gangrene, or death, of the skin; it necessarily involves similar changes in the appendages of the skin—i.e., the hair and nails. These unpleasant effects are caused only by X rays coming from tubes in a certain condition, which will be spoken of later on. People differ in their susceptibility to this action of X rays, just as all are not equally burned by direct sunlight; but given the proper conditions, and it is possible to induce in any one a Dermatitis Roentgenii more or less severe.

In describing the probable cause of this inflammation, the author points out that light is one form of energy—a form of what is called radiant energy—and can do work just as any other sort of energy. When a ray of light falls upon a molecule in the emulsion on a photographic plate, the ray is said to be "absorbed," its energy is expended in changing the construction of the molecule. If the plate is now treated with certain chemicals it will be found that the change effected by the energy of the ray of light has made such a change in the molecule by which it was absorbed as to make that molecule possess entirely different properties from the others. If enough molecules have been affected, the result will be quite perceptible to the eye. Roentgen rays act, so far as their results are concerned, in precisely the same manner. When the X rays fall upon a sensitive plate some of them are absorbed by the molecule in the emulsion and the arrangement of the molecules changed, precisely as it would be changed by light. Consequently we know that the X rays are a form of radiant energy and that they do work, though just what sort of radiant energy we do not know. We know that electricity will do work, but we do not know what electricityis.

In the same way, when sunlight falls on the skin, it affects the molecules, rearranges them and produces noticeable changes. The light energy is mostly expended in heating the surface exposed—we stand in the the sun to get warm—but some of it is absorbed by the molecules and produces "tan" or "sunburn," and this last may be so extensive as to result in serious inflammation, blistering, suppuration, etc. So will exposure to the X rays affect the skin; but as certain conditions of exposure to light will alone produce marked changes in the skin, so too are special conditions of X rays necessary to produce inflammation.

Continuing, Dr. Jones writes: "It is not generally known that there are several, if not many, different varieties of X rays, each sort possessing its own peculiar properties. In June last I communicated the fact that I had discovered a number of different kinds of X rays to one of the principal electrical journals in this country, and was most ignominiously snubbed. In the last number of the same journal there are three articles on that subject, and a long editorial calling attention to the value of this discovery. There may be as many forms of X rays as there are colors and gradnations of light; as yet we do not know more than the one fact that all X rays are not precisely similar.

"Probably every one knows how X rays are produced; that through a vacuum tube is passed an electric current of a large number of volts, and that X rays are emitted by the tube. Few people, however, except those who have experimented with the apparatus, know that the vacuum tubes are constantly changing—that a tube, while it is being used, alters materially. In some unknown way the vacuum increases as the current is passed through it and becomes higher and higher. Only a certain amount of vacuum can be obtained by means of any known pump, but the passage of the electric current may increase this vacuum a hundredfold.

"As the condition of the vacuum changes, so the characteristics of the X rays which come from it change. These changes and differences can be recognized only after long and careful observation of many tubes, but when once thoroughly known the exact nature and peculiarities of the rays coming from any given tube can be recognized at a glance. Generally when the tube is new and is first used the X rays emitted are in considerable quantity, but are easily absorbed. They affect a plate profoundly, but will not go through the flesh of the hand to any extent—they have no penetrative power. As the vacuum increases the character of the rays changes, then increase in penetrative power and are less readily absorbed; consequently they affect the sensitive plate and the skin less than under the former conditions. By carefully study-

ing the phenomena of tubes, therefore, it is quite possible to make exposures to the action of X rays without anticipating any untoward consequences. Aided by this fact, I have made hundreds of exposures without a single casualty. I am at present working on some experiments to ascertain whether there is any effect on the deeper structures, bones, etc.—resulting from absorption of the rays. Thus far, however, the changes I have been able to observe have been purely superficial.

"Dr. Martin Regensberger, whose opinion on skin disturbances is worth considering, says that the inflammation caused by Roentgen rays is a true gangrene or death of the cells, and that this could easily be accounted for by a chemical change in the molecules, caused by the expended energy of feeble rays. As all that class of X rays which have but little penetrative power would be stopped by the skin and absorbed by the molecules in the skin, we should naturally expect to see most of the trouble confined to those tissues.

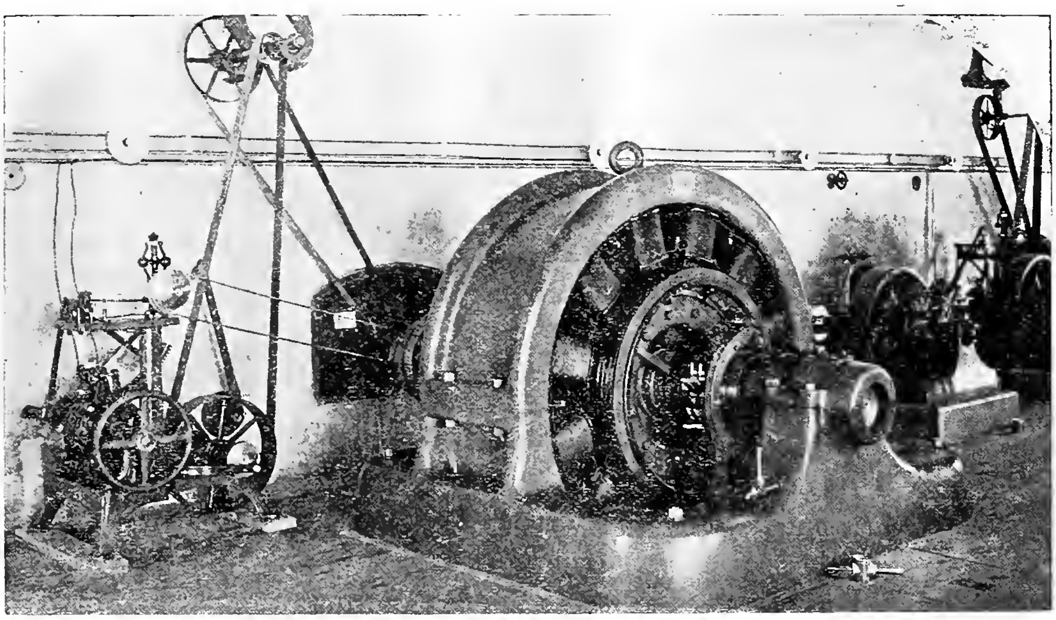
"We find, then, that X rays of a certain sort are absorbed very readily by the molecules of the skin; that these rays so change the chemical nature of the molecules that the cells die and gangrene of the skin results, but that as all X rays do not act in this way it is not necessary for every exposure to them to be followed by inflammation of the skin. Roentgen rays may be, in careless hands, both harmful and dangerous; but used with skill and in the light of experience, they are free from danger and of great benefit."

The light of the starry sky has been found by Captain Abney to be about 1-44 that of the full moon, which is placed at 1-600,000 that of the sun at noon.

Transmission

REPOGLE GOVERNORS IN THE FRESNO PLANT.

The only material alteration that has been made in the transmission plant of the San Joaquin Electric Company of Fresno, Cal., since the description of the installation appearing in the April number of the Journal, has been in changing the water wheel governors as described previously to the ones appearing in photographic reproduction on this page. The well known Replogle governor, which has been freely described in the technical press of late, is now used exclusively and so satisfactory is its operation that Mr. J. S. Eastwood, Vice President and General Manager of the company, is authority for the statement that the regulator keeps the speed within two per cent of normal at all times, even when the 150 kilowatt synchronous motor driving the Sperry Flouring mills, is thrown on to the circuit.



REPOGLE GOVERNORS IN THE FRESNO TRANSMISSION PLANT

INGENIOUS, AT LEAST.

A fruitful cause of collisions at sea during fogs is to be found in the difficulty experienced in locating the position of foghorns, sirens and other sonorous signals. One of the devises lately brought out for removing this danger consists in two microphones, one in the bow and the other in the stern of the vessel. The bow microphone is connected with a telephone placed at the right ear, and the stern microphone with another at the left ear of the observer, who otherwise is isolated from the sound of the signal. Taking the speed of the sound and the time it takes to travel the length of the ship, the observer can estimate the direction of the fog signal. When both sounds are simultaneous the signal is at the right angles to the vessel.

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EDITORIAL.

A WORD ABOUT THE JOURNAL

The lateness with which this publication is making its appearance has brought out such universal expressions of regret from every quarters as to emphasize the esteem in which it is held and to establish beyond doubt the necessity for its continuance. And continued it shall be.

A word then in mitigation of the offence it has committed against the unwritten ethics of journalism. No mistake has been made in matters of style and of policy. The Journal of Electricty from the very outset has been in true accord with the ideas and desires of its readers; its patrons have been from the East and from the West; its subscribers are found in all quarters of the globe from the Dominion of Canada to Guatemala, from London to Hai Phong. It is welcomed in every country as the magazine in which is recorded the progress of practical engineering development in the Far West,—its superiority in many features has been lauded by its readers and the technical press at home and abroad. Commercially it has from the very outset, and is even yet, a paying property.

What then, can be said in defense of its lateness of issue, which is its only short coming? The time was ripe for a first class electrical periodical when the Journal was instituted, as its success attests, but in truth it must be said that the Journal was then hardly ripe for the time in that its proprietor had other matters in hand which, though quite unforseen, so developed in importance as to demand his entire attention to the exclusion of the business of the Journal. Deplorable as was this neglect, it can only be said in extenuation that it was unavoidable. Relief has at last come; all matters outside of the Journal have been finally disposed of and today the proprietor finds himself free to prosecute the interests of his paper to the exclusion of all other affairs.

Most sincere and grateful appreciation is felt toward those whose fidelity to the Journal has led them to patiently endure its tardiness and to remain steadfast in its support during these, its days of trial.

CONSERVING POWER ON RAILWAYS

Periodically there appears some genius who aspires to fame and fortune through the invention of a device for conserving the energy of railway trains in going down hill or in coming to stops and in turning to useful account the energy thus stored. The latest to bring out such a scheme is a Buffalo man, Warner by name, who proposes to attach, as he says, "a small dynamo to the axles of steam cars so that when they are running down hill enough electricity will be generated to carry a train up the grade, or to take most of the pull from the locomotive." Mr. Warner has experimented with his models, and although he had no locomotive, he is reported to have found by a register attached to "a pulling contrivance" that the electricity generated going down one hill was sufficient to equalize the resistance occasioned by a heavy adverse grade of equal length. He thinks that the saving of coal alone and the increased capacity of locomotives would more than pay any big railroad company for the expense of equipping their coaches with the devise in less than a year.

Every one who has noted the condition of the brake shoes of the cars of a railway train that decends a mountain grade, or who has figured on the terrific momentum of a moving train, must have been impressed with the waste of energy that is ever occurring with consequent losses of power in all railway systems. Roughly speaking, were it possible to determine the amount of coal consumed in starting a given train and in pulling it up a given grade, some idea might thus be formed of the power that is wasted in the form of heat developed by the brakes in taking the train down the grade and bringing it to a standstill. The fascination of saving this power by electrical means has allured inventors but those of broader experience have thus far failed to devise a commercially feasible

scheme for attaining the end that has long been sought for.

Without inviting the complications which the intricacies of heavy railway trains makes necessary, the operation of street railway cars affords most advantageous opportunities for the perfection of the idea. They are, for instance, already equipped with motors (or dynamos) on their axles; the fields of these dynamos may be charged to any desired point of saturation from the trolley circuit giving the perfect means of a separately excited dynamo for securing a maximum armature effort or output; the cars are electrically connected to other cars through the trolley wire and rails; oftimes electric roads are run through territories covering many heavy but short grades and the frequency of service on such lines makes it probable that while certain cars are going down a grade other cars will be ascending grades. Despite these advantages and the fact that the ablest electrical inventors in this country have grappled with the problem, practically no advance has been made and the energy of the descending car is lost as it has ever been.

No effort is being made to depreciate the importance of conserving the power thus wasted particularly on steam lines. Unquestionably it is there and unquestionably it will eventually be made available but it will not be through the use of a dynamo delivering electricity to a storage battery of the present form Far more rational than this would be the accumulation of power by compressed air, filling receivers to a high pressure and conveying the energy thus accumulated to the locomotive, whence it will be delivered to the cylinders after having been reheated in the fire box. The efficiency of such a system would be very high and the apparatus employed would be inexpensive as to first cost and maintenance. Compressors could be placed under each car and in the air pipe to the engine as with air brakes and receivers of small dimensions could be located on the engine or tender. At the Presidio the Rix air compressors delivered air to receivers at a pressure of 2000 lbs. to the square inch, and there would seem to be nothing to prevent the delivery of an equal pressure to receivers placed on a locomotive. This being done there is nothing to prevent the delivery of heated air to the boiler or cylinders at boiler preassure through the use of pressure reducing valves, and the energy thus delivered certainly means the saving of coal in direct ratio to the power accumluated.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

A PRACTICAL TREATISE ON COMPRESSED AIR AND PNEUMATIC MACHINERY: By Edward A. Rix and A. E. Chodzko, Pneumatic Engineers for the Fulton Engineering and Shipbuilding Works. About 500 pp., bound in flexible leather with gilt edges.

This is the title of a recently issued book, which, while it illustrates machinery designed by Mr. Rix and manufactured by the Fulton Iron and Shipbuilding Works, of San Francisco, is certainly much more than a trade catalogue; for it treats of the underlying principles of the production and use of compressed air in a concise and most masterly way.

The use of compressed air is not new, but the field of its usefulness has extended very rapidly of late because engineers are coming to realize its peculiar fitness for certain conditions. A striking example of this fitness is given in the beginning of the text of this book. Briefly this is as follows: A number of years ago a mine was to be equipped with a power plant. There was an ample water power several miles away, but neither the water nor the mechanical energy could be transmitted to the mine. Wood for fuel was plentiful and cheap. A first class steam plant was put in. After a time fuel became scarce and expensive, and a change became necessary. An electric transmission from the available water-fall would leave the steam plant valueless. But an air compressing plant at the water-fall could furnish compressed air through pipes to run the engines which had previously used steam. The boilers would serve for reservoirs or heaters. In case of a break down of the compressing plant, the compressed air connection could be shut off and the steam plant could be used as before. Independently then of the actual relative efficiency of the electrical and compressed air transmission, the latter is better fitted for this place. Incidentally this example also brings out clearly the necessity for the treatment of modern engineering problems individually, with careful study of all modifying conditions.

Following this is a treatment of the thermo-dynamics of compressed air. The authors are to be congratulated upon the accuracy, completeness and conciseness of this treatment and upon the omission of unnecessary mathematical analysis. The modification of theory by practical considerations, such as loss of pressure in passage through long pipes and through bends, the influence of difference of level, etc., are clearly treated. Then follow the explanations of the use of compressed air for refrigeration and in engines for the development of power. The first part concludes with the solution of several problems in detail of compressed air transmissions.

Two very valuable features of the work are, the

introduction of many numerical examples with the solutions in full, and of tables and graphical diagrams worked up from the best available experimental data. These cannot fail to be of great use to the engineer who has to deal with problems involving the use of compressed air. The book is not only a very valuable contribution to the literature on the subject, but it stands alone as the only exhaustive handbook which has been published for the information and guidance of the pneumatic engineer.

Bulletins of the University of Wisconsin, Engineering Series.

Emergencies in Railroad Work, by L. F. Loree, 40 pp., 35c.

Railway Signalling, by W. McGrafton, 35 pp., 35c.

The Problem of Heat, Light and Power Supply, for Building Blocks, School Houses, Dwellings, etc., by G. Adolph Gertzen, 60 pp., 45c.

A Complete Test of Modern American Transformers of Moderate Capacity, by A. H. Ford, 88 pp., 35c.

The Bulletins of the University of Wisconsin from which we have selected four for our notice, consist of lectures delivered by special engineers conversant with the particular problems treated and delivered before the different engineering departments of the University. Being generally delivered by practical men and not practical educators the pamphlets contain a great deal of definite information collected through many years of actual service and are in consequence of great interest and value to engineers interested in these special subjects. Mr. Loree, who writes on Emergencies in Railroad Work presents the results of many years' experience with divisions of the Pennsylvania Railroad having headquarters about Pittsburg. After reviewing his experience in clearing general wrecks and very clearly specifying the proper equipment for a wrecking train, he gives the results obtained from such an equipment during five years of service. Following this general section a description of the reconstruction of the Pennsylvania Railroad in order to quickly renew communication after the Johnstown flood is given. The concluding portion is devoted to the part taken by the railroad wrecking service during the strikes of 1894, giving a graphic account of the methods used to maintain communication with Chicago during that difficult period. The whole paper gives an impression of the wonderful efficiency of the Pennsylvania Railroad wrecking department and emphasises the necessity of establishing such a department in order to maintain uninterrupted travel.

The second paper on "Railroad Signalling" explains the block and interlocking systems in use from an engineers standpoint, leaving the methods of handling the signals and switches, by electric, hydraulic or pneumatic power, to the specialists in each department; the discussion being devoted to the efficiency of the various systems employed from the standpoint of an operating engineer, although as we have said, the author expresses no opinion concerning the various systems of operating the various systems of signals from signal towers. We would judge from his statements that the electric automatic railroad signals and blocking systems are unreliable and not equal in efficiency to manual service.

In the third Bulletin Mr. Gerdtzen appears as an advocate of fuel gas as a means for heating and furnishing light and power to building blocks. His conclusions may, however, be easily criticised on the score of incomplete details concerning total cost and maintenance of the different systems, no clear comparisons being made of various plants in operation. In the first pages of his pamphlet he disposes of the claims made by the advocates of electric heating systems by showing that 770 horse power in engines and dynamos must be installed in order to furnish the heat which might be delivered by a 50 horse power boiler, used direct and where a large volume of air must be continuously heated, there can be no criticism of his deductions. In heating for three or four hours per day, a problem which is often presented in our climate, a higher efficiency could be obtained from electric heating and it will compare more favorably with a steam boiler that must necessarily be wasteful of coal during the stand by periods; at the same time we believe that electric heating apparatus will scarcely present an economy under such circumstances even though it be that the present systems are comparatively wasteful, and we believe that the installation of large electric heating systems can only be contemplated where the question of repairs becomes more important than the actual consumption of coal. In this essay a comparison of the cost of transmission using gas and electricity is made and the results given decidedly favor the use of gas though the question of generation is not sufficiently considered for a complete comparison. The pamphlet may, however, be advantageously consulted by any one desirous of knowing the results that have been obtained in the transmission of gas both through short distances by the ordinary pressures and over considerable distances with pressures of 600 pounds per square inch. The efficiency of heating by gas stoves, firing boilers with gas, the economy of gas engines and the most improved methods of gas lighting are all here well treated and one would rely upon his data concerning the use of gas rather than upon the conclusions drawn in comparing gas with steam and electricity on account of the fact that the treatment of the two latter does not include all of the points in question.

In the "Complete Test of Modern American Transformers" made by Mr. Ford we would first criticise the form of report given on account of the fact that it is impossible to determine the make of the transformers giving the record as no less than twenty-one transformers varying in capacity from 450 to 1,000 watts were tested, comprising all except two of the modern

American makes. The efficiencies vary most decidedly and were the names of the different transformers given, valuable data to installing engineers might be obtained from the tests, but as such names are suppressed the work remains to be done again by some one willing to give unprejudiced facts concerning the apparatus available in the electrical market. The results of these tests were given by Prof. Jackson in his paper before the North Western Electrical Association in July, 1895. Indeed one of the most valuable parts of this paper consists in a standard set of specifications proposed by Professor Jackson. It is further interesting to note that most of the transformers tested would conform to these standard specifications and also that considerable improvement is-shown by American transformers over the English transformers tested by Dr. Fleming in 1892. Another part of the paper that strikes us as being valuable consists of a description of the testing methods employed and the calibration curves given for the various instruments used which show that although good ammeters, voltmeters and wattmeters can be generally relied upon, correction factors must be introduced in order to obtain the best results. This cannot be too carefully observed by engineers who are too apt to rely upon the original calibration which even in the best instruments is susceptible of some change. The methods of testing are ones that are easy to follow by practical engineers and it is to be hoped that this series of tests may be repeated and the results published without any suppression of data necessary to useful information.

ELECTRICITY NEAR THE NORTH POLE.

It is well known that electricty was used for illuminating purposes on the Fram in the Polar Expedition. Some account of this method is given in a Norwegian paper, which states that general regret was when in May, 1895, it was decided that electricity must be dispensed with, owing partly to the wearing out of the gearing of the cog-wheel in the windmill which worked the dynamo, after the vessel had entered the ice, and partly to the fact that portions of the apparatus were required for making snow shoes and runners. Mr. Nordahl took advantage of every puff of wind to load the accumulators, so that they were kept continually charged, and until May of last year the electric light was always available. In the severe cold the accumulators froze through, but the acid-blended ice proved an excellent electrolyte, and the frost did not interfere with the working of the accumulators. On festive occasions Nordahl suspended an arc lamp in the saloon, which gave such an excellent light that Dr. Nansen frequently used it when painting or photographing. When the two explorers left the ship, the arc lamp was run up to the top of the mainmast as a farewell greeting. The rigging was so thickly coated with ice that it had to be broken to pieces before the lamp could be fastened to the ratlines. Electricity was also used for other purposes besides lighting, the mining shots which set the Fram free from the grip of the ice being fired by means of a cable attached to six Leclanche cells. The entire electric installation worked admirably.

Physics

HEAT ENGINES AND CARBON BATTERIES.

The triumph of the steam engine over all other generators of motive power is one of the most marked revolutions of the century. Many other motives have been tried, and we frequently read in our daily papers, of wonderful inventions that are destined to overturn all of our industries, and relegate the steam engine to the scrap heap. The hot-air engine, for example, promised very well; but it has not fulfilled its promise, and although it is often quite serviceable where a small amount of power is needed, it has never been in any sense a rival of steam. Motors using the vapors of ammonia, ether, carbon disulphide, and other volative substances, have fared even worse; and thermo-electric batteries, pyromagnetic generators, and other such devices, have never been found to be of any practical use. In spite of the discouraging failures of these various contrivances, inventors are still busy at the problem. Its solution, we think, is bound to come. Man seldom invents a thing that cannot be replaced by something better; and it would be strange indeed if the steam engine proved to be the last product of inventive genius —a device to be improved, indeed, but not to be supplanted.

The trouble with most of the inventors who are seeking for a better motive power is, that they do not know the fundamental laws that underlie the heat-engine. These laws are only two in number, but one of them, unfortunately, cannot be fully understood without a considerable knowledge of mathematics. The first law governing the action of heat-engines—known as the "first law of thermodynamics"—is the familiar one which declares that heat and mechanical energy are mutually convertible, 780 foot-pounds of work (or there about) being equivalent to one unit of heat. This law is readily grasped, and is universally understood and admitted by engineers. The second law of thermodynamics is more simple for it merely states that heat always tends to pass from a hot body to a cold one, and never from a cold body to a hot one; but although it is indeed simple, its full consequences are by no means easy to trace out.

The "first law" has received a considerable amount of attention from writers on popular science, and was very clearly examined and discussed in Tyndall's book on "Heat Considered as a Mode of Motion." The "second law," however, has never been treated in the same way, so far as we are aware; and we are by no means sure that it could be so treated. Rankine pointed out the lack of popular information of this kind nearly thirty years ago.

The "second law" which, in its simplest form, merely states that heat always tends to pass from a hotter body to a colder one, is far-reaching in its consequences. It was first proposed, as a broad and universal principle of nature, by Lausius; and although numerous distinguished mathematicians and physicists have questioned its validity from time to time, it is now recognized as a great, universal truth, applicable without exception to all classes of phenomena. It is obvious enough in its simpler manifestations: every housewife knows that to make the kettle boil, she must put it on the stove, and not in the refrigerator. In less familiar cases, however, its truth is not always so obvious, and that is why it did not at first receive the general acceptance that has since been accorded to it.

We cannot undertake to trace out the results of the "second law" in this place. One of its important consequences, however, is that no engine could utilize all the heat that it takes in, even if it were absolutely perfect in workmanship and entirely free from friction, radiation, and other similar losses incident to all actual engines. There is a limit to the performance of every kind of heat-engine, which cannot be exceeded, however perfect its construction may be. In the case of a condensing steam engine, in which the drip from the condenser is returned to the boiler again, the greatest possible efficiency is expressed by the fraction

$$\frac{T-t}{T+460^\circ}$$

where T is the temperature of the boiler and t is the temperature of the condenser, both being expressed on the Fahrenheit scale. For example, let us suppose such an engine is using steam at 115 lbs., and that the back-pressure in the condenser is 2.9 lbs. The temperatures corresponding to these pressures are T — 347 deg. and t — 140 deg., respectively; and hence the greatest possible efficiency of such an engine is

$$\frac{347^\circ-140^\circ}{347^\circ+460^\circ}=\frac{207^\circ}{807^\circ}=.256$$

or 25.6 per cent. That is, we can build the engine as finely as we please, guarding against every conceivable kind of loss, and yet, so long as we run it under these conditions, it will never utilize more than 25.6 per cent of the heat supplied by the boiler; nor could we realize more than this, by using any other vapor in the place of steam.

A similar limitation is set by nature on every imaginable form of motor, which transforms heat-energy into mechanical energy. The thermo-electric battery, for example, is subject to just the same law as the condensing steam-engine. The thermo-electric battery, in its best known form, consists of a series of bars of bismuth and antimony, soldered together at their alternate ends, so as to form an electrical circuit. Every other junction (i. e. the first, third, fifth, seventh, etc.,) are heated, and the remaining ones (i. e. the second, fourth, sixth, etc.,) are cooled. Under these circumstances a part of the heat that is supplied to the hot junctions is transformed into electrical energy, and an electric current is obtained. This, in turn, may be used to operate an electric motor, and so, by a kind of roundabout process, we have heat-energy transformed into mechanical energy. If T represents the temperature of the hot junctions, and t that of the cold ones, the greatest possible efficiency of the apparatus (when considered as a heat motor) is given by the formula quoted above, just as in the case of the condensing steam engine. The efficiency may indeed be far less than the formula indicates, but it cannot, under any circumstances, be greater, no matter whether the thermo-electric arrangement is constructed of bismuth and antimony, as assumed above, or of any other substances. Inventors have spent a great deal of time and labor upon the improvement of the the mo-pile, which might have been saved and devoted to some more useful end, if the limitation imposed by the second law of thermodynamics had been properly understood.

The second law, as has been said, imposes a limit on the efficiency of every form of heat-motor. We cannot evade this limitation by superior modes of construction, for it is fixed by the very nature of heat. Any apparatus that first converts the chemical energy of the fuel into heat, and then transforms the resulting heat into mechanical energy, is necessarily subject to the law referred to; but if we could discover some method of obtaining mechanical energy from the fuel without the intermediate transformation into heat, the second law would no longer apply, and we could very likely devise a form of motor that would greatly exceed the steam engine in efficiency.

It is very likely that this problem is solved in the animal body, for here we find muscular force and mechanical work, derived, to all appearance, directly from the chemical energy that resides potentially in the highly organized tissues of the body. There is little or no evidence that the animal body is a heat motor. Mammals and birds are warm, it is true, but that is probably because requisite chemical changes cannot occur at a lower temperature. Frogs, fishes, worms, and molluscs are cold, and yet they can solve the problem too,—sometimes in most vigorous fashion. We know very little about the processes that go on in the muscular system. Further research will probably give inventors some valuable suggestions, but at present our knowledge of physiology is too slight to show us how to build a successful motor.

Leaving the animal economy out of account, the only other method that we know of, for transforming chemical energy into the mechanical form, without the intermediate use of heat, is afforded by the galvanic battery. This method is certainly full of promise, though so much thought has already been spent upon it that the present outlook is not so encouraging as it might be. The great difficulty with the galvanic method is, that heretofore every convenient and practicable form of battery consumes zinc, and zinc is too expensive to be of much use as a fuel. If we could only devise some feasible kind of a battery that would consume carbon instead of zinc, we should stand some chance, perhaps, of removing the steam engine from its present proud position. Numerous attempts of this kind have been made already. Twenty years ago, or more, a form of battery was devised by Jablochkoff, in which carbon was the substance consumed. The Jablochkoff cell does not pretend to be more than a scientific curiosity, but it isl nevertheless interesting.

"The liquid of this cell," says Niaudet, "is melted nitrate of potash or nitrate of soda; one electrode is of coke, and the other of platinum, or even of cast-iron. The coke is burned at the expense of the oxygen of the nitrate, and produces torrents of carbonic acid. The cast-iron remains unattacked. The coke (cast-iron?) is therefore the positive electrode, and the cast-iron (coke?) the negative. It is the contrary of that which would take place in a battery with an ordinary liquid, acid, or salt dissolved in water. The nitrate should be previously melted, but as soon as the action begins the salt remains liquid on account of the great heat produced by the combinations which take place; and if the element be left to itself it suffices, to put it in action, to bring the end of the coke to a glowing red heat, and then to press it against the surface of the salt. The chemical action begins immediately. . . . It might be found that such a battery cell presents nothing practical in its actual form, and we do not hesitate to express that opinion but we believe that it points out a new way in which much progress might be made if the attention of physicists were turned in that direction. Volta's battery itself, when invented, was a purely scientific novelty, and it was far from being regarded as an object of any practical utility."

The quotation here given will show that the idea of constructing a carbon-consuming battery is by no means new. We have no doubt that it was tried even

before Jablochkoff's time, but we have no record, at this office, of any earlier experiments. The latest attempt in this direction is due to Dr. Jacques, whose invention has attracted so much attention that a description of it in some detail may be of interest. Each cell consists of a cast-iron pot, which serves as a containing vessel, and at the same time acts as the positive electrode. The negative electrode consists in a stick of carbon, which is placed centrally in the cell. The iron cell is nearly filled with caustic soda or caustic potash, which is kept in a state of fusion by means of a furnace, from the interior of which a stream of air is blown into each cell at the bottom, and, is caused to bubble up through the liquid caustic by means of a sort of flat-shaped rose nozzle. The apparatus being constructed as described above, and connected up with wires, it is found that a considerable current of electricity can be obtained from it.

Dr. Jacques' theory of the cell seems to be, that the only function of the furnace is to keep the caustic melted; so that by jacketing the battery thoroughly the consumption of fuel in the furnace could be reduced so as to be relativelyinsignificantand unimportant. He appears to ascribe the electric current to the oxidation of the carbon rods in the cells, the oxygen needed for this oxidation being furnished by the air which is blown up through the molten potash. In the course of some tests carried out by Dr. Jacques and others with this idea in mind, the loss in weight of the carbon rods was compared with the output of electrical energy yielded by the battery, the result being that the apparatus showed an efficiency, in one case, of no less than 87 per cent. The fuel burned in the furnace, being supposed to be of minor importance for the reason stated above, was not estimated. The electromotive force of a single cell of the battery was found to be about nine-tenths of a volt. There is a strong similarity between Dr. Jacques' battery and the earlier form invented by Jablochkoff, the chief difference being that the oxygen is furnished by the electrolyte itself in one case, and by the steam of air bubbles in the other case.

If further experiment should substantiate the assumption of Dr. Jacques, that the electrical energy obtained from his battery is due solely to the oxidation of the carbon rods, there can be no doubt that the invention would be of the first importance; for although carbon rods are more expensive than ordinary coal, and the battery would be more likely to get out of order than a modern steam engine is, the wide margin of efficiency in favor of the new device would probably much more than compensate for these difficulties. But unfortunately such outside experiments as have been made do not justify the inventor's hypothesis at all. Mr. C. J. Reed, for example, has shown that the carbon rods act merely as conductors, and that they can be replaced by iron, brass, copper, German silver, or other metallic bodies, without detriment to the battery. He found, further, that the disintegration of the carbon rods is merely incidental, and that if good arc-light carbons are used, they do not suffer any sensible loss. He also found that the cell works much better and lasts much longer if the caustic potash is replaced by nitrate of potash, precisely as originally recommended by Jablochkoff. Finally, Mr. Reed found that illuminating gas may be substituted for the air, without lessening the electrical yield of the apparatus.

Mr. Reed's experiments establish the fact, beyond a reasonable doubt, that the source of the energy given off by the Jacques battery is the fuel that is consumed in the furnace below the pots. The device is not a galvanic battery at all, but a sort of thermo-electric apparatus, working on the same principle as the old bismuth-antimony arrangement, and subject to precisely the same laws. The chemical energy of the coal in the furnace is first transformed into heat, and then into electrical and mechanical energy. The significance of these words is great, for they show that Dr. Jacques has not evaded the second law of thermodynamics. His battery and motor constitute a true heat-engine, and are subject to the very limitations that fix the maximum efficiency of the steam engine.

We do not say that the new battery will not be useful. It is no small advance to construct a thermo-electric combination that can yield so large a voltage. and if the efficiency of a battery turns out to be as great as five or six per cent, it will doubtless be useful in many ways. But the ideal galvanic battery, which consumes carbon instead of zinc, is yet to be discovered.—The Locomotive.

Obituary

MONROE GREENWOOD.

It sometimes happens that occasions arise when a fraternal industry, forgetful for the time of the otherwise ceaseless strifes of competition, joins with practical unanimity in expressions of common feeling concerning events that are of mutual interest, whether the feeling evinced is of a direct or indirect nature or whether the occasion be one of rejoicing or sadness, hearts are moved by mutual impulse and the fellowships or kindnesses of human nature manifest themselves in the sympathetic signs of congratulation or of condolence, as is meet.

So it was that the electrical interests of the Pacific Coast with one accord were pained to learn of the death of Mr. M. Greenwood, not only for the intrinsic worth of his sterling manhood, but as well for the loss of the one who may fitly be termed the father of electrical enterprises on the Pacific Coast. Being a pioneer in "The days of Gold," his name stands above all others in the priority of electrical undertakings in the far West. Mr. Greenwood's long career of usefulness, terminated in his very sudden death in San Mateo, Cal., Oct. 11, 1896, of heart failure.

Monroe Greenwood came of an old New England family of English ancestry as the surname indicates. He was born in Dublin, Cheshire County, New Hampshire, where he was raised and educated and where his training was naturally that usual to most New England boys of the good old families. As a result of what he had read and heard of California, he came hither in February 1852. At that time, mining was the great industry of the State, and being among the thousands who went to the mines, Mr. Greenwood located on the American river where he spent about a year in mining, principally in 1853. He followed this avocation in all about three years, after which he located in San Francisco is a result of the firm conviction that this city was destined to become a great commercial mart.

The situation at that time was such as to lead Mr.

Greenwood to believe that the field of telegraphy in the far West was a most promising one, as a result of which he was engaged by the Western Union Telegraph company to build and take charge of the division of the overland telegraph line extending from Fort Churchill, Nev., to the Coast. This was a very important section of the line and a reflection of Mr. Greenwood's ability as a telegraph manager is found in the highly successful results both financial and electrical, which that enterprise shows. His next move was in the building and equipping of the fire alarm and police telegraph system of San Francisco, where for ten years until 1875 he occupied the position of superintendent of the fire alarm telegraph.

The invention of the telephone about this time at

MONROE GREENWOOD

once interested Mr. Greenwood who clearly foresaw the indispensible part that telephony must soon take in the business world and he resigned his San Francisco fire alarm superintendency in order to inaugurate electrical enterprises which he rightly believed would develop into valuable properties, and as a result of his work the district telegraph and telephone company was incorporated in March, 1875. On October 14th of that year, the business of the newcompany was well in hand under the general superintendency of Mr. Greenwood who held the position until July 28th, 1877 when it was relinquished for the treasurership. The electrical developments at that time were rapid in certain lines and most notable among the new enterprises inaugurated was the incorporation of the Gold and Stock Telegraph company on April 15th, 1878. In this company also, Mr. Greenwood was an active promoter and from the time of its inception he held the position of director and treasurer of the concern.

Among the other enterprises in which Mr. Greenwood was interested either as originator or as purchaser, were the various concerns that were consolidated by the articles of incorporation of the California Electric Works, dated 1877. By this consolidation the California Electrical Works succeeded to the business of the Electrical Construction and Maintenance company organized in 1868 and incorporated in 1870, the California Electric Power company, the Pacific Electro-Depositing Works, and the California Electric Gas Lighting Company, and as is well known now, the California Electrical Works stands to-day the largest and best equipped general electrical supply house on the Pacific Coast. Considering the fact, that with the exception of a very few months, Mr. Greenwood was president of the California Electrical Works from the date of its incorporation, it is evident that the business has been built up through his untiring perseverence and ability.

In this connection it is interesting to note that in 1870 the business of the Electrical Construction and Maintenance Company was located on the corner of Montgomery and Jackson streets, San Francisco. Mr. Geo. S. Ladd was president, while Mr. Stephen D. Field, whose name is now known in every part of the electrical world, was manager and electrician. In 1871 the company moved to 134 Sutter street where it remained until the concern was absorbed by the California Electrical Works.

About a year after the incorporation of the Gold and Stock Telegraph Company the probabilities of telephony had so expanded as to make it advisable that the telephone industry should, so far as possible, be under the control of a distinct corporation, with the result that the Pacific Telephone and Telegraph Company was then incorporated by Mr. Greenwood and associates, since which time Mr. Greenwood has been a director both in the Pacific Telephone and Telegraph Company and in the Sunset Telephone and Telegraph Company.

Personally Mr. Greenwood joined few societies or orders as his business interests and his love of home and family always took up the greater portion of his time. Throughout life he has been very conservative, and the electrical industry could not have had a more faithful and persevering worker than was to be found in the lamented Mr. Greenwood. His extensive interests will be well taken care of by his sons, George D., and Frederick A. Greenwood.

THE EFFICIENCY OF ELECTRICTY FOR TOOL DRIVING.

An English ship-building yard has installed an electric power plant for driving portable drills, cranes, wood deck planing machines, punching machines, fan blasts, etc., displacing steam power and effecting by the change a saving in the weekly consumption of coal of from 72 to 38 tons.

The Trade.

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

PLASTIC RAIL BONDS.

The difficulties that have long been experienced in the bonding of rails of electric railway systems to secure the best possible return circuit have led to the invention of various devices, none of which present more originality than that recently placed on the market by Harold P. Brown of New York, who in bringing out his Plastic Rail Bond has made a radical departure from all other methods heretofore followed in that the bond is composed of two portions: a plastic or putty-like metal compound which makes contact between the rail and the metal of the joint, and a flexible, elastic cork case to hold same in position, as near the end of

COPPER BONDS.

Test No.	100 Amp	200 Amp.	300 Amp.	400 Amp.	500 Amp.	600 Amp.	700 Amp.	800 Amp.	900 Amp.	1,000 Amp.	1,100 Amp.	1,200 Amp.	1,300 Amp	1,400 Amp.	1,500 Amp.
1	0.025	.05	.08	.10	.12	.16	.18	.20	.22	.24	.25	.32	.33	.34	.38
2	0.025	.05	.08	.10	.11	.135	.145	.18	.20	.23	.245	.26	.28		.34
3	.017	.035		.07	.084	.10	.12		.15	.175		.20		.24	.26
4	.01	.02	.03	.04	.05	.06	.07	.08	.09	.12	.132	.144	.156		.18
5	.01	.02	.03	.04	.05	.06	.07	.68	.09	.10	.11	.12	.13	.14	.15
6	.006	.012			.03	.035	.04	.05	.055	.06	.065				.09

PLASTIC BONDS.

7	.005	.01	.015	.02	.025	.03	.035	.04	.045	.05	.055	.06	.065	.072	.086
8	.004	.008	.012	.016	.02	.025	.03	.036		.04	.044	.048	.052		.06
9	.0045	.009			.017			.03	.032	.034	.038	.04	.042	.044	.046
10	.004	.008	.0085	.009	.0095	.01	.012	.013	.015	.017	.019	.02	.025	.03	.04
11	.003	.004	.0055	.0078	.0085	.01	.012	.013	.014	.019	.02	.024	.025	.028	.03
12	.0004	.0008	.001	.0016	.002	.0025	.0028	.0036	.004	.0045	.0048	.005	.006	.0062	.0064
13	.005	.01	.016	.022	.025										
14	.004	.008	.012	.016	.018	.024		.032	.036	.04					

about two inches in diameter on both rails and plates are cleared of rust and scale and treated with a solid alloy which instantly silvers the surfaces and prethrough a plastic band to the angle plate, thence through a second bond to the next rail. Contact spots the rail as possible. The current passes from one rail vents them from rusting. When properly applied the conductivity of the completed point is affirmed to be equal to that of the rail. The bond for a 9 inch rail, for instance, will carry 1,500 amperes with a drop of but 0.03 volts, while the best copper bond of $\frac{5}{8}$ inch rod has, even while new, more than 10 times this drop and its loss increases rapidly with time.

The accompanying table sets forth a series of rail bond resistance tests made by Mr. Franklin Sheble at the laboratory of the Cutter Electrical and Manufacturing Co. in Philadelphia, during September last. Standard Weston instruments were used throughout the test, and the varieties of bonds used in the respective tests are as follows, the number of bond appearing below, corresponding to the test number as given in table:

Test No. 1. Chicago Bond. 36 inches long, 0.4375 inches in diameter with a $\frac{7}{8}$ inch hole in the rail. The bond was smoking hot at the end of five minutes test.

Test No. 2. Columbia Bond. 24 inches long, 0,4375 inches in diameter, $\frac{7}{8}$ inch hole in rail. Sizzling hot at the end of 7 minutes test.

Test No. 3. W. Bond. 2.75 inches between centers, $\frac{3}{8}$ by 5-16 inch, one-half inch hole in rail. Scorching hot at the end of six minutes test.

Test No. 4. Johnston Bond. 20 inches long, 0.4375 inches in diameter, taper hole 13-16 and $\frac{3}{4}$ inch diameters. Very hot at the end of six minutes test.

Test No. 5. U. Bond. Laminated copper. 2.75 inches between centers, $\frac{3}{4}$ inch by 3-16 inch, $\frac{7}{8}$ inch hole in rail. Very hot at the end of seven minutes test.

Test No. 6. Nichol's Plastic Bond. Amalgamated Copper loop, 6 inch by 2 inch by $\frac{1}{8}$ inch on bottom of 90 lb. rail, with hollow receptacles in each end for plastic alloy. The bond was cold at the end of ten minutes test. Its carrying capacity equals 1 2-3 "U" or 4 Chicago bonds.

Test No. 7. Plastic Plug Bond. 60 lb. rail joint with one pair of $\frac{5}{8}$ inch holes through one angle plate only. Cold at end of 10 minutes test. The bond equals two "U" or five Chicago bonds.

Test No. 8. Plastic Bond on 60 lb. rail point under one angle plate only, cold at the end of 10 minutes test. The bond equals $2\frac{1}{2}$ "U" or six Chicago bonds.

Test No. 9. Plastic Plug Bond on 60 lb. rail joint with one pair of $\frac{5}{8}$ inch holes through two angle plates. Cold at the end of 10 minutes test. The bond equals 3 "U" or 7 Chicago bonds.

Test No. 10. Plastic bond on 90 lb. rail joint under one angle plate only. Cold at the end of 10 minutes test. The bond equals $3\frac{3}{4}$ "U" or 9 Chicago bonds.

Test No. 11. Plastic Bond on 60 lb. rail joint under both angle plates. Cold at the end of 10 minutes test.

Bond equals 5 "U" or 12 Chicago bonds. T.

Test No. 12. Plastic Cup consisting of a V-shape slot cut in the web of the rail at joint with steel cup holding plastic alloy. Cold at the end of 10 minutes test. The bond is beyond comparison with other bonds. T.

Test No. 13. Plastic socket of No. 000 amalgamated copper resting in holes in rail filled with plastic alloy. Tested with double its proper current and warm at the end of ten minutes, with 500 amperes. This bond was designed for 250 amperes and was cold at that load.

Test No. 14. Plastic sockets of 2 No. 0000 amalgamated copper strips resting in holes in rails filled with plastic alloy; as in test No. 13 this bond was tested with double its proper current and was warm at the end of 10 minutes, though cold at 500 amperes for which it was designed.

In making these tests all copper and steel contracts were absolutely bright and made in the best possible manner by the Cutter Electrical and Manufacturing Company. In the table the amperes given at the top of the columns represent the current transmitted while the figures given for each test record the drop in volts.

The plastic alloy is shipped in small wooden boxes; each box holds the exact amount necessary to make one contact between rail and angle plate. Each rail joint requires two such boxes. On heavy rails each box also holds one amalgamated spring washer which can be compressed to less than the minimum distance between web of rail and inner surface of angle plate. The cases to hold the plastic alloy are made of flexible cork, treated on the surface with a sticky compound; they will not deteriorate in service. To prevent their sticking together they are packed in waxed paper and powdered chalk and should be kept in a cool place until used.

In addition to the sphere of usefulness which flexible solder fills in making rail joints, it also presents unequalled advantages for use on contracts for bus bars, switch boards, dynamo terminals, etc., and the heating of switches can be stopped by amalgamating the blades and contacts and keeping same lubricated with the flexible solder. On the very best switches, the application of this material will show that the contact was previously made upon a few high points. After application it is evident there is a perfect surface contact.

Moreover, the application of a little flexible solder to main switches carrying heavy currents will demonstrate the existence of unsuspected station losses, and in this connection an interesting experiment can be made with a Weston milli-voltmeter by taking the drop in voltage with a given current on a given switch before and after applying flexible solder. If no millivoltmeter is at hand comparative readings that will be equally instructive may be taken by disconnecting the lead wires of a Weston ammeter from its shunt and applying them as with the milli-voltmeter.

The Pacific Coast agency for the Edison-Brown Flexible Solder or plastic rail bond has been placed with the Abner Doble Co. of San Francisco.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Elec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

The Journal of Electricity

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A Model Isolated Plant.

When it was announced that the Parrott Estate proposed to erect a great building in the most prominent portion of Market Street, San Francisco, for the purposes of a department store that was to be the largest and most magnificent establishment west of Chicago, there was not a little stir created in the electrical fraternity in regard to the lighting of this structure. The original plans proposed the installation of approximately four thousand incandescent lights and five hundred arc lights, together with sixteen high duty electric passenger elevators and numerous motors distributed throughout the building for various uses. As work on the structure progressed it was announced that the contract had been awarded for the installation of Siemens & Halske dynamos to be direct driven by triple expansion marine type engines built by the Union Iron Works of San Francisco. This contract called for the installation not only of engines and dynamos, but also of boilers, air condensers and every appurtenance of a high class steam plant, together with a switchboard that is one of the most elaborate of any to be found in any isolated plant in the country. The contract for the wiring of the building was secured by Mr. E. H. Forst for the California Electrical Supply & Construction Co., while the elevator contract was awarded to the Sprague Electrical Elevator Co. of New York. The electric plant was installed on plans and specifications furnished by Mr. A. E.Brook-Ridley, the well known electrical engineer of San Francisco and who is Pacific Coast agent for the Siemens & Halske Co.

At the outset it was evident that the plant would embody many interesting features as the specifications imposed that it would be necessary to fulfill the following conditions of operation:

First, That all elevators and power circuits should be operated at a potential of 220 volts.

Second, That all arc and incandescent lighting circuits should be operated at 110 volts.

Third, That each dynamo should be of a potential of 110 volts and that any pair of dynamos may be run in series for operating the elevator and power circuits, or any single dynamo may operate the arc and incandescent circuits, as may be desired.

Fourth, That the lighting circuits may be divided between any pair of dynamos without reversing the arcs.

Fifth, That the lighting and power circuits may be operated from the same or different sets of machines as desired.

Sixth, That the above combination should be so made that it would be impossible to throw a pressure of 220 volts on to the lighting circuits under any condition.

It was determined that these conditions could best be satisfied by installing the dynamos in pairs, each pair being connected to an individual engine, and the plant was installed accordingly. The power circuit runs from bus-bars totally independent from those supplied for the light circuits, the latter being run in conjunction at any time desired by means of switches. For the control of the light are furnished two entirely independent sets of bus-bars, one set connecting the feeders to the dynamos on the left hand side of each engine, and the other set to the right hand dynamo. Further switching arrangements have been provided, so that the entire lighting system may be run from either side of the dynamos on each engine or divided up between them.

To secure an economical loading of the engines the lights run by each dynamo were balanced up by additional switches transferring any portion of the load from one dynamo to the other. The system of switching also permits, if desired, either one or both of the small dynamos to be thrown in multiple on either side of the light circuit, if for any reason one side should be too heavily loaded for the balancing switches to take up.

The total current produced by the generators was divided into three parts at the switchboard, these being first, the power circuit of 220 volts; second, the circuit for arc lights; and finally, the circuit for incandescent lights.

The current passing out on these circuits is independently measured by Thompson recording watt meters, and the output from each circuit is indicated by Weston illuminated dial ampere and volt meters.

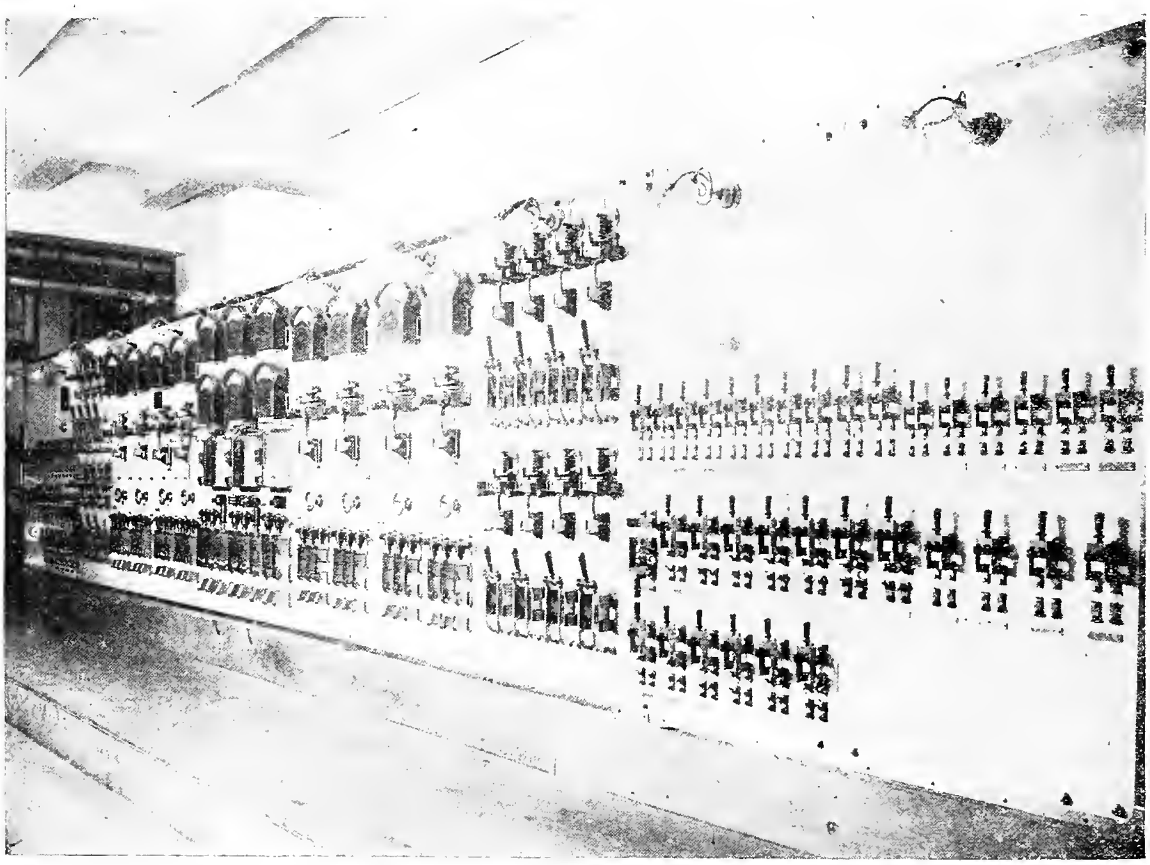
The generating plant consists of eight Siemens & Halske external armature standard commutator machines; eight being of 100 kilowatt capacity each and two being of 35 kilowatts each. The dynamos are of

the well known Siemens & Halske type, the fields being placed within the armatures. These armatures are of the Gramme type, and the windings are constructed of copper bars insulated from each other and the core by fibre insulation, the external portion of the winding forming the commutator. The result of this construction is to secure a very small difference of voltage between adjoining bars and to prevent completely the burning out of the armature under excessive overload. It also diminishes to a minimum the internal resistance of the dynamo. Tests of this plant have already shown high efficiency for these machines, and they have been frequently operated at fifty per cent beyond their rated capacity.

From the dynamos current is carried to the proper sections of the switchboard through stranded cables, each having an area of 1,000,000 circular mils, the cables being run in iron pipes filled with insulating compound and imbedded in the concrete floor.

The switchboard is of marble and constructed on the panel type, having a length of forty feet, and being divided into ten panels and one central panel. Four of the panels are mounted with apparatus for the control of the eight dynamos, each pair of dynamos occupying one panel. Two panels are filled with the switches and circuit breakers necessary for the control of the sixteen elevators and the motor circuits, and the remaining four panels are devoted to the switches controlling the arc and incandescent lights throughout the building. Each dynamo is supplied with a 3 pole main switch, regulating rheostat, circuit breaker and Weston illuminated dial ampere meter.

On the center panel are placed 2 voltmeters, 1 Weston ground detector, 3-2000 ampere ammeters, also 3 Thompson recording watt meters, having capacity of 2000 amperes each. The volt meter switch is so arranged that either volt meter can be used for the purpose of throwing in additional machines in multiple, but in normal use these instruments are used for ascertaining the voltage of the pair of dynamos running in series.



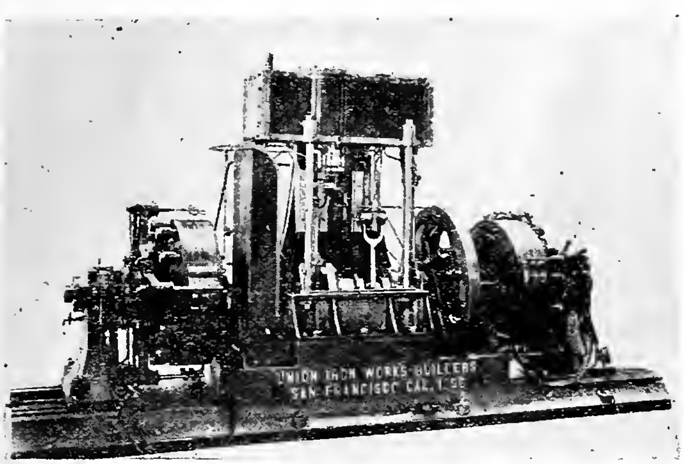
On the center panel are also placed the large switches for transferring the load to the various sets of bus-bars, and also the switches connecting or separating the light and power arcuits. Switch connections are also provided for supplying the entire building from the street circuit, if at any time in the future this course may be deemed advisable.

The current generated by the dynamos is brought to this center panel by a system of eight bus-bars, where it is divided up into the various portions and fed out to the light circuit switches and to the switches on the elevator and motor panels.

The entire bus-bar systems consists of massive bare copper bars and is entirely without the use of insulated cables except in connecting the dynamo and switchboard as stated, and of course in the distribution of the

various building circuits. The power panels of the switchboard control the 16 Sprague-Pratt expansion sheave electric elevators and the various motor circuits, each circuit being protected by a double-pole main switch and an automatic circuit breaker. In this connection it is interesting to note that while both the lighting and power circuits are operated simultaneously from the same set or sets of machines, the regulation in practice is found to be so close as to render the variation in the incandescent lights inappreciable. It may be readily imagined the fluctuation in load is very great as the use of the elevators alone throws on a variation in load of from 0 to 1000 amperes. As is evident, the building is wired on the simple two-wire system for 110 volt lighting and the switchboard effects such combination between the lighting and power circuits, that while the two dynamos of an engine set are each carrying an incandescent and arc lighting load at 110 volts, the two dynamos are also coupled in series and carrying a power circuit at 220 volts.

The lighting of the building proper and particularly



of the Emporium is beyond compare with anything in the West in the way of decorative lighting effects for a mercantile establishment. The results attained resemble most closely those looked for in the lighting of exposition buildings and indeed the lighting of the great dome over the elaborate bronze orchestra stand and cafe in the Emporium is a marvel of beautiful effects. From the very outset the brilliancy of the establishment coupled with the excellent music that is there heard on concert evenings, together with the infinite variety of displays exhibited has found favor with the public. The dome contains approximately 1800 16-candle power incandescent lamps, while the corridors are brilliantly illuminated with Bergmann arc lamps and the side walks and store fronts being lighted with Manhattan enclosed arcs. The entire wiring together with the placing of the Bergmann arcs was done by Mr. Forst and in addition to the electrical plant proper, Mr. Brook-Ridley installed the Mahattan lamps.

The steam plant is of model excellence and no expense has been spared to make it perfect in every regard. Briefly expressed, the entire plant has been installed on the most modern designs and in regard to efficiency, durability and high-grade workmanship, it ranks among the best. The boiler plant consists of four, 250 horse-power internally fired boilers of the marine type combined with the Howden forced combustion system. in which hot air is taken from the top of the boilers and forced through the furnaces. Not only the steam pipings. but every inch of the boilers and all other steam parts are heavily covered with felting and and entire pumping, piping and condensing plant is in duplicate so as to provide for any possible emergency. The boiler plant, besides supplying steam for electric installation, supplies the power and heating system as well as the laundry, kitchen and restaurant connected with the building.

The engines to operate these dynamos are of the Union Iron Works vertical triple expansion condensing type, being a modification of the type built by them for the Market Street Railway Company and were designed especially for direct connection to Siemens & Halske dynamos. The cranks are each placed at an angle of 120 degrees, thus insuring a perfect balance of all moving parts. and the governing is entirely controlled on high pressure valves, each pair of dynamos being connected, one at either end of the shaft of the engine supported by outboard bearings. The balance of the unit has been made so equal that it is found that the weight of the dynamo armatures is ample to give the closest regulation and steadiness of running without the addition of usual heavy and dangerous fly wheels.

The quantity of water obtainable was quite insufficient for condensing purposes. and therefore a system of condensation is employed whereby air is used in the place of water, using merely a spray of water to cool the air. This design gives excellent results.

Considered from an engineering standpoint, the installation placed in the Parrott Building constitutes the highest attainments possible in an isolated plant and every improvement that could add to its durability, reliability or efficiency has been placed, and that it reflects great credit on all concerned in its construction, is not to be doubted.

A GOOD PAPER, EDITORIALLY AND MECHANICALLY.

"I have just read the May and June numbers of the Journal of Electricity, having found them among a lot of papers on my desk. I do not know whether they are sent here to Hotel del Coronado or not. We get so many papers that I can not keep track of them, but the Journal, editorially and mechanically, is such a good paper that I would like for you to send it to my address and have it marked 'personal' if you can, so that I will be sure to see it personally. Send bill and I will have the cashier remit." E. S. BABCOCK,

Mgr. Hotel del Coronado.

Coronado. Cal.

Transmission

THE NIAGARA-BUFFALO TRANSMISSION.

The 16th of November, 1896, marks an epoch in the history of Buffalo and one in which the whole manufacturing aspect of that busy city within a short time may be metamorphosed. One minute after midnight, with the closing of five sets of switches the power from the cataract at Niagara was brought into the City of Buffalo.

The history of the generating station of the Niagara Falls Power Company is already so well known that it will not be referred to except to say that the three great two-phase generators are all in use furnishing power to the factories in and immediately around Niagara. The most recent addition to the power-house equipment is one of the General Electric Company's converters to take the two-phase current from the generators at 2,200 volts and turn direct current into the lines of two or three railroad companies at a pressure of from 575 volts to 600 volts.

When the question of the transmission of power from Niagara to Buffalo was under discussion, the merits of the three-phase system as compared with the two-phase system for transmission purposes were canvassed. It was shown to the satisfaction of the Power Company that, in using the three-phase system for transmission, a large economy could be made in the transmission installation, and the three-phase system of the General Electric Company was selected.

The current from the Falls is generated by the Niagara Falls Power Company which transmits the power as far as the city limits of Buffalo. All the construction work in connection with this installation was effected by the Cataract Construction Company, while the distribution, after it has reached the city limits, is in the hands of a sub-company entitled "The Cataract Power & Conduit Co."

The two-phase current starting from the generators in the power-house is led first to the switchboard and then in lead-covered cables through the covered "Bridge of Sighs" which passes over the canal of the Niagara Falls Power Company to a spacious transformer house which has been erected on the opposite side of the canal. Here the cables are connected to four switches on a blue marble switchboard. From this board, they pass to the step-up transformers, the largest in the world, erected on a platform at one end of the power-house and placed over an air-tight chamber. Each has a capacity of 935-kw or 1250-hp and stands 94 inches high on a base "64x56," and weighs 25,000 lbs.

The problem of cooling these transformers has been solved by driving a blast of cold air up through the air passages provided in the core and coils. The blast is furnished by a large blower driven by a 5-hp, multipolar motor which is belted to it. It is in these transformers that the two-phase sysem is abandoned and the current given three phases, and raised from 2,200 volts alternating to 11,000 volts. Provision is also made in these transformers for raising the voltage to 22,000 volts as soon as higher pressure shall have become necessary.

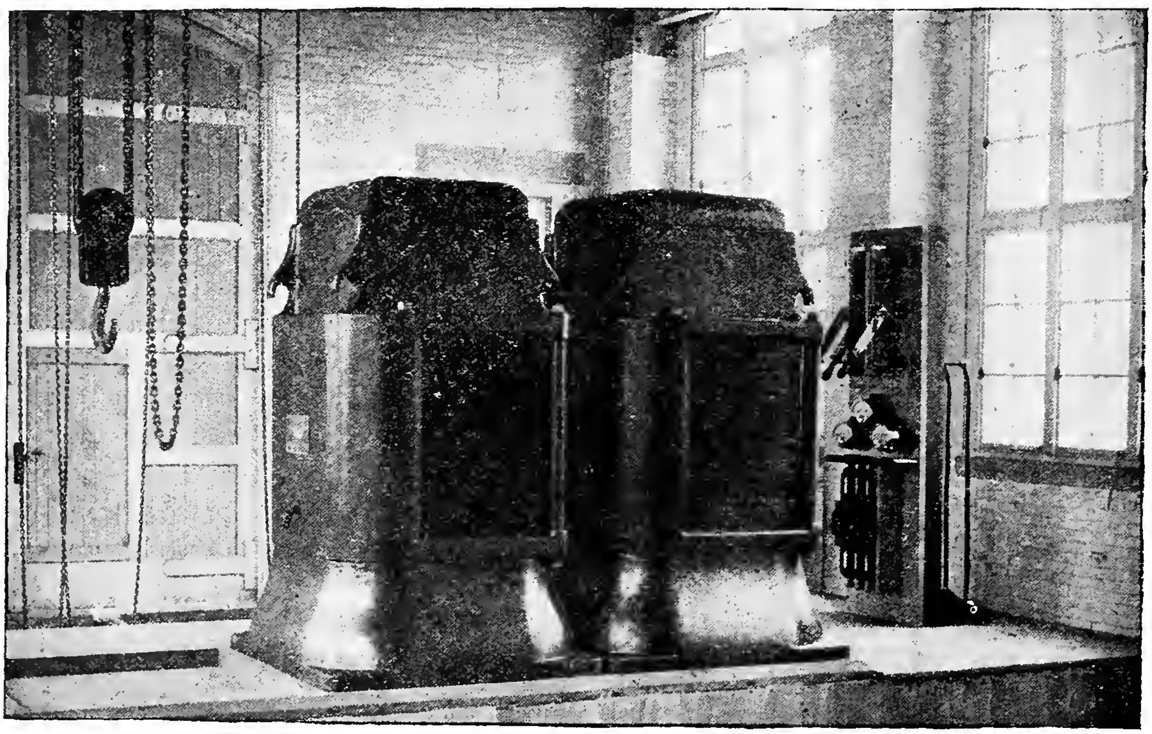


FIGURE 1—THE 1250 H. P. STEP-UP TRANSFORMERS AT NIAGARA

From the transformers three cables pass to the high tension switchboard standing beside them. This switchboard is also of marble and carries three high tension switches, each switch being separated by a marble barrier about one inch thick. This partition prevents arcing from switch to switch at the high pressure used. The switchboard also carries current indicators and three special fuse carriers. From the transformer house, the wires pass through lightning arresters to the first pole of the pole line standing immediately in the rear of the building.

The pole line erected by White, Crosby & Co. runs

along one side of a special right of way 30 feet wide. The number of poles in this line is about 21,000; they range from 35 to 65 feet in length and are set about 75 feet apart. Each pole is provided with two 12 foot cross-arms for the transmission line, and one small cross-arm for a telephone line. Each side of cross-arm has space for three pins to carry three insulators, provision being thus made for four circuits of three wires apiece; the capacity of each circuit being 5,000-hp at 11,000 volts pressure, and 10,000-hp. at 22,000 volts pressure. On the outside of each upper cross-arm is a small iron pin 18 inches high, which serves to carry a galvanized barbed wire used as a lightning conductor and connected to the ground at the foot of every fifth pole.

The insulators used are of the double petticoat pattern. Each weighs about 12 pounds and is provided with two angular grooves in the bottom, which effectually prevent any moisture getting to the central pin on which the insulator is placed. The outside of the insulator is provided with a gutter running to a point on each side to carry off the water. These insulators were subjected to a rigid test of 40,000 volts alternating, to determine the electrical resistance, and not until they had withstood this pressure satisfactorily were they accepted.

The length of the line is twenty-six miles. The overhead conductors are of bare, stranded copper, each conductor having a diameter of 350,000 circular mils, and each lies in a groove at the apex of the insulators. When the line approaches the station at Buffalo, which it does along the banks of the Erie Canal, it is charged from overhead to underground; the wires passing from the last pole into a small brick terminal house. In this house, connections are made with the underground cables through lightning arresters. The underground cable is rubber covered and sheated with lead, and is of the same diameter as the overhead conductor. It is laid in a subway consisting of vitrified tile ducts, each duct having a hole three inches in diameter. The sub-way consists of twelve of these ducts, laid eighteen inches below the surface of the ground, and surrounded on all sides by four inches of concrete. Three ducts only are in present use. The insulation of these cables was tested to withstand 80,000 volts.

The sub-way terminates in a small brick structure erected in the rear of the Niagara Street Power-House of the Buffalo Railway Company. This contains the step-down transformers. On entering this small house, the wires are connected to another switchboard carrying high voltage switches and fuse carriers separated by partitions of marble in the same manner as on the high tension switchboard, at the Niagara Falls end of the transmission. From this board, cables are carried through lightning arresters to the transformers, of which there are three, two being in use and the third held in reserve. Each weighs 7,000 lbs., is 82 inches high with a base measurement of 47 by 36. In the step-down transformers, the pressure is reduced from 10,700 volts to 370 volts. A system of cooling the transformers similar to that used with the step-up transformers at the Niagara end is used.

From the step-down transformers, the three-phase current, divided into two circuits, passes over six cables to the main floor of the Power House of the Buffalo Railway Company, where they are connected to another switchboard. Thence they pass to the two rotary converters, each of 500 h.p. capacity. These converters are six-pole machines, and in their operation, the three-phase alternating current at 370 volts is changed into direct current at 500 volts, suitable for delivery to the feeder line of the electric street railway. Each converter armature is provided with

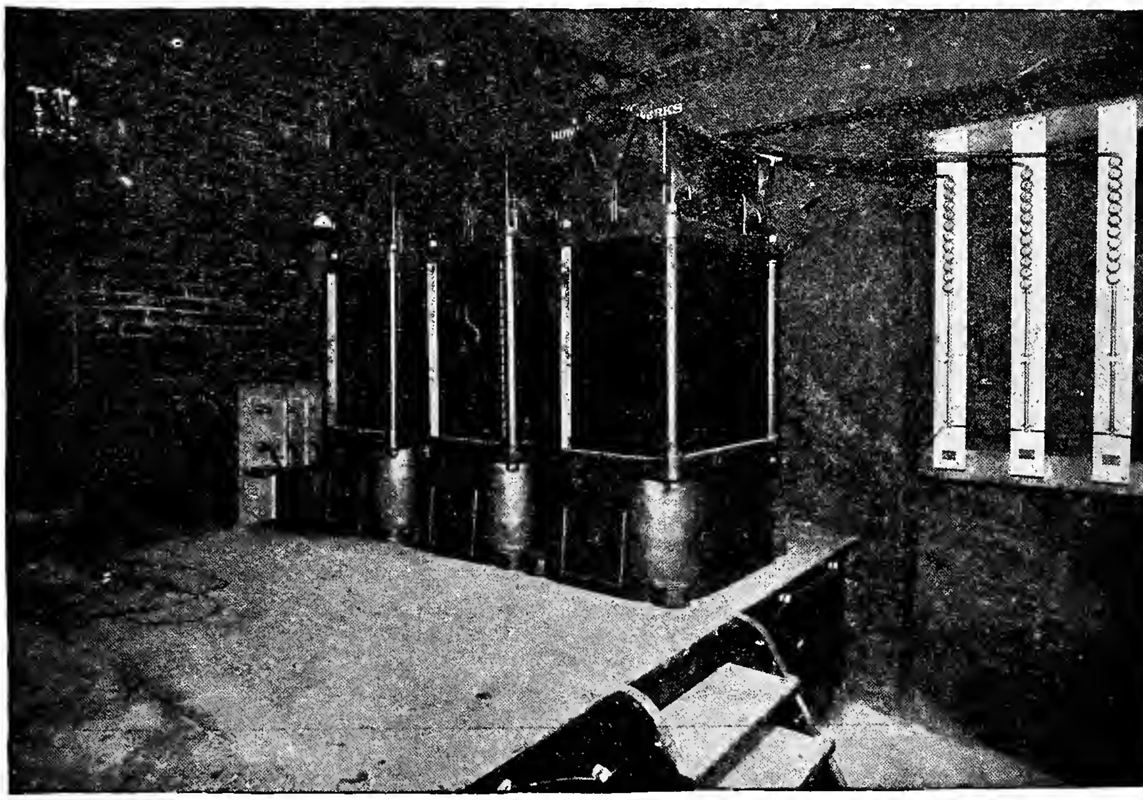


FIGURE 2—THE STEP DOWN TRANSFORMERS AT BUFFALO

three collector rings at one side and a commutator at the other, and may be started either by the alternating current or by direct current from the railway lines. The converters may be used in parallel with the other generators, or the current can be thrown directly into the feeders of the railway system.

The lightning arresters of the Wirt type have been especially designed for heavy voltage transmission work and are single pole. They consist of strips of marble upon which are mounted eleven cylinders so as to give one air gap space of 1-32 in. for each one thousand volts, with an allowance of 25 per cent rise in the potential. In the action of the arrester, the large metal cylinders serve to chill the arc so that, on reversal of the current, the arc is extinguished, no dependence being placed upon any non-arcing property of the metal to put out the arc. In order to limit the current on short circuit, and thus the heating effect, a special solid graphite rod of low non-inductive resistance is used. The arresters are similar to those used on the Big Cottonwood transmission at Salt Lake City, which have effectually protected the machinery in many severe storms and are now being used extensively in transmissions where high voltages are employed.

The entire apparatus used in the transmission of the current from Niagara Falls to Buffalo is from the shops of the General Electric Company, having been designed especially for this service.

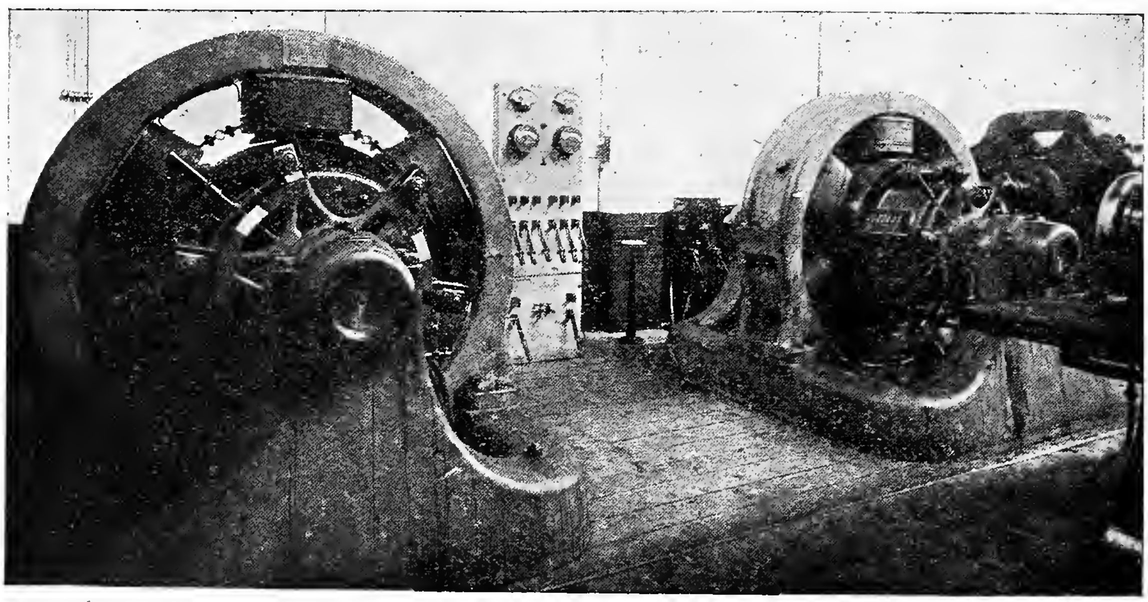


FIGURE 3—THE ROTARY CONVERTERS AT BUFFALO

PERSONAL.

Mr. J. H. Follis, of the enterprising Brooks-Follis Electric Company, has returned from a business trip to New York and other Eastern cities.

Mr. Willard Ives Warriner, long prominent in electrical circles in Honolulu, H. I., where he was for some time electrical inspector for the Honolulu Board of Fire Underwriters, has left the Islands and has located in Los Angeles.

Mr. H. A. Heywood, President of the West Coast Advertising and Publishing Company, and who recently assumed the business management of the Journal of Electricity, has resigned the latter position and left for New York City, where he has become identified with Katz's well known Advertising Agency.

Mr. George J. Henry, Jr., of the Pelton Water Wheel Company, and who is engineer for the New York office of that concern, was married on November 25th at San Francisco, to Miss Clarisse Adele Fisher, a daughter of Mr. and Mrs. H. S. Fisher of this city. Mr. Henry is a Californian, who first became prominent through his official connection with the Editorial Department of the World's Columbian Exposition, since which time he has been connected with the engineering department of the San Francisco office of the Pelton Company. He is an occasional contributor to the Journal of Electricity and other magazines. Their friends at the Golden Gate, in extending congratulations to the happy couple, wish them unbounded success and happiness in their new home.

ELECTRICTY DID IT, OF COURSE.

Nearly all the bells in town have been on a spree during the past two days, and whether it just happened so, or if the electricity in the air is the cause, is a question.

Saturday night, during the little thunder storm to which the town was treated, the big bell at the fire department would tap with every flash of lightning. Yesterday morning, the bell that for twenty years has not struck the hour at the clock building, attempted to revive memories of the past, and tolled off eleven solemn strokes; people who heard it, thought the veteran clock had begun its rounds again, but they were disappointed.

At six o'clock yesterday morning, the chimes at the Fithian tower continued to ring after the hour had struck, and as in the case of the town clock, no reason can be given.—Santa Barbara, Cal., Independent.

ELECTRIC POWER ON THE B. & O.: By T. Fitzgerald, Genl. Supt. B. & O. Railroad.

It is with some little hesitancy that I write even a short sketch on a subject which has been so exhaustively dealt with from its several aspects; however, if public interest still remains active in following the results of this great enterprise and undertaking on the part of the B. & O. R. R., it is with pleasure that I review its growth.

It was in the pioneer days of electric lighting, that the B. & O. R. R. installed its first electric light plant for the purpose of furnishing, in a small way, arc lights at several of its points in Baltimore. Since that time the railroad has found it advisable and to its interest, to take up the use of electricity both as a means of light, as well as motive power, probably more extensively than any other steam railway corporation, and the results have been both successful and gratifying.

The adaptibility of the various applications of electrical energy as viewed from the point of economy is shown by making a comparison of its equipment of but a few years ago, with that of the present, which has grown to the extent that this railroad is now operating thirteen plants, with two additional ones now under consideration, representing in all some 1,500 2,000 candle-power arc lights, 9,500 16 candle-power incandescent lights, and 3,300 horse-power in the shape of power.

Among this list of stations, one of recent and greatest interest, is the one located in Baltimore, commonly known "Belt as the Tunnel plant," which has a rated capacity of 4,500 horse-power. Due to the difficulty and uncertainty of a ferry transfer, particularly in the winter time, on account of navigation being closed and the railroad being dependent upon this connecting link at Baltimore, coupled with the desire to lower the schedule time of its trains running between Washington, Baltimore, Philadelphia and New York, the question arose as to how this might best be accomplished. After careful consideration, it was finally decided to construct underneath the city of Baltimore, a suitable underground tunnel. At the inception of this great undertaking no definite plan had yet matured as to the exact manner in which trains should be operated through this tunnel.

In 1892, when the tunnel was nearing completion, it was found necessary at once to take up the question of determining quickly and definitely how these trains should be handled, because on account of the great length of this tunnel (which is about one and one-half miles) it was decided, from experience in this direction, that some different means of motive power than steam or some means of ventilation, would be required, not only as a matter of safety and convenience in operation, but considered from a point of comfort to passengers, and employes of the road.

After considering all points in favor of and against the several plans submitted for accomplishing the results desired, it was in May, 1892, that the contract was formally closed for installing a suitable electric plant together with specially constructed electric locomotives for the purpose of hauling freight and passenger trains through this tunnel. From the above date, progress in the way of perfecting plans and arrangements was rapid, and in May, 1893, ground was broken for the power house, which was to furnish power for the operation of these electric locomotives.

This work, together with the overhead construction, progressed uninterruptedly until its completion in June, 1894. On June 27, 1894, the first trial trip over the Belt Line with the electric locomotives was made. The entire length, including the tunnel proper and its approaches from either end, at that time was about three miles. This trial trip was satisfactory, and on August 4, the electric locomotives went into regular service, and have been in use up to the present time, pulling all freight trains.

While those who had examined into the operation and pulling power of these electric locomotives, were confident of their ability to perform the work required, it was not until October of the same year that all doubts as to this were dispelled. It was on the fourth day of that month, due to some misunderstanding on the part of the operator that two trains numbering in all forty-four loaded cars, together with three dead steam locomotives all coupled together, were stopped in the tunnel and started again by the electric locomotive, which did its work apparently as easily as with any ordinary train.

It was on a five-tenths grade that this performance was made, the total weight of the train being nearly 2,000 tons. The electric locomotive with this load, developed a speed of about eight miles per hour, exerting at times over an eight-tenths grade at the extreme end, a drawbar pull of about 62,000 pounds.

In the way of speed, with an ordinary passenger train, fifty miles per hour has been attained up this grade.

For some time after these locomotives were put in service, a great many railroad men, myself included, were skeptical as to the results they would ultimately produce, but from a practical standpoint, I am free to say that the electrical locomotives operated by the Baltimore & Ohio Railroad on the Baltimore Belt Line are without question a perfect success.

This latter statement confirms itself by the fact that we are now making additional extensions which, when completed, will give a total length over which these electric locomotives will operate, of about four and one-half miles.

A PATRIARCH WITH DIVERSIFIED INTERESTS.

The new street car tickets have arrived. They have on one side a fine lithograph of the old Mission under which is the inscription: "Built in 1776. C. W. Miller, president."—Santa Barbara, Cal., Independent.

THE JOURNAL OF ELECTRICITY.

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EDITORIAL.

INSULATED UNDERGROUND CONDUITS

Considerable attention has again been called to insulating underground conduits by the introduction of what seems to be the best form offered up to the present time by the Interior Conduit and Insulation Company of New York, and recently described in many of the technical journals. The question of an insulating conduit is an old one and when underground conduits were first established, insulation was considered to be one of the greatest requirements; the conduits then offered were not practical in construction, being made of asphaltum blocks which would not remain in alignment and in consequence the system has fallen into disuse; the conduit is now merely considered as a hole in the ground without other office but that of simply mechanically protecting the cables. The question now arises of determining whether it would not be possible to obtain a better conduit and cheaper installation of cables where the conduit itself is an insulating one and the manhole system carefuly worked out along the same lines.

The problem, however, is more complicated than appears from the first statement and the failure of the early insulating systems was not entirely due to the mechanical imperfections of construction, but also to the fact that although it may be possible to exclude water from the duct system, it is never possible to entirely exclude moist air which will ultimately condense within the ducts and deliver a very considerable amount of water to the walls of the system, making it as necessary to obtain careful insulation within the conduit itself not only from the ground but from the adjacent cables as would be necessary were the insulating features altogether abandoned. Furthermore, such a system of construction seems apt to facilitate complicated faults in any system where defects may occur in the cables themselves; should a leak occur the insulating character of the conduit would prevent an immediate burn out of the cable, but it would not prevent a leak occurring between two neighboring cables which might both be faulty as the currents follows along the film of condensed moisture and along the lead covering of the cables, should lead covered cables be used in the system. Indeed, these troubles with semi-insulating ducts have lead to the general method of grounding the lead of all cables as frequently as possible; for until this practice became general it was found that many mysterious burn-outs occured simultaneously at different points of the system. In these instances the leaking currents following along the lead covering to a weak point in any other cable within the ducts.

Should it be possible to abandon leaded cables altogether with an insulating conduit system, it would appear possible to maintain pure air by a drying-out apparatus and with such a construction the insulating conduit system would be efficient, and though greater reliability would be secured, it is questionable whether a great amount of expense would be saved were these practices introduced.

WATER-WHEEL REGULATION

It is the experience of every electric installation operated by water power in the West, if not throughout the entire country, that he greatest difficulty in the way of securing perfect service rests in the governing of the water wheel, and this is true whether the wheels be of the turbine or of the tangential type. Until a year since there were but few electrical plants of magnitude that had been able to improve upon manual regulation, and it was with interest engineers watched or partook in the battle between science and the laws of nature that was waged in the efforts to secure regulation that would prove to be smooth and reliable under exacting conditions. Science has at last, however, achieved a partial, if not an entire victory, but the surrender of the enemy has not been an unconditional one, for it is yet necessary in some cases to use separate generators and transmission lines for lighting and electric railway service, nevertheless, there is reason for believing that if it has not already been accomplished, the near future will bring about a satisfactory condition in the governing of every type of water wheel.

An appreciation of the difficulties encountered may be had by reference to the problem which confronted the hydraulic engineers engaged upon the construction work of the San Joaquin Electric Company last spring. Operating, as this plant is, under a head of 1411 feet and with a running gauge pressure of 609 lbs. to the square inch, the conditions at once present the most trying and severe that have yet been assailed. It is quite impossible to conceive of the terrific energy of a stream of water under this head without having witnessed it. The impact of the water cuts down cement-

ed masonry almost as a gravel bank, and it has even cut into heavy sheet steel plates to the depth of an eighth of an inch after a few days run. The roar of the water against the Pelton wheels reverberates through the canyons of the San Joaquin for a distance of five or six miles and the deflection of a nozzle for but a fraction of an inch causes a difference of over a hundred horse power in the power of a wheel.

The end thrust of the pipe line under normal conditions is tens of tons, but should the usual flow of the water be disturbed or suddenly checked, then the end thrust can be measured only by the hundreds of tons. Indeed under such instances the elasticity of the pipe makes it "breathe" and throb like a giant reptile.

To govern the water wheels operating under these conditions became a most trying task and experience soon taught that none of the old types of regulators would fulfill the conditions. The enormous force of the water, coupled with the terrific and almost resistless energy of water ramming and the readiness with which the governor would throw the jet beyond the hair line of proper impact for the desired speed, all conspired to defeat achieving the end sought for. It is with pleasure, therefore, that we record in another column that the regulation of these wheels has been brought down to within a variation of within two per cent of normal—a performance which is considered satisfactory even in high class steam engine practice.

The successful performance of the Replogle governors at the power house of the San Joaquin Electric Company, together with the report of highly successful operation of the Lighthipe electric governor in the transmission plant in which it is being used near Sonora, Cal., seem to warrant the belief that a satisfactory governor for controlling water wheels, and which will prevent the exasperating "see-sawing" that has been ever present, is at last at hand.

THE PRICE OF SAFETY

The action of the Receivers of the Baltimore & Ohio Railroad in putting on an extra man to take up tickets on excursion trains, thereby relieving the conductor to give his full time to the running of the train, affords evidences of the realization which is becoming daily more impressed upon corporate managements as to the price of safety. This action is the outcome of much discussion which has been had within the last few years in railroad circles concerning the handling of excursion and other trains carrying large numbers of passengers. A number of times accidents have happened to these heavily loaded trains and, almost invariably, investigation developed the fact that the conductor was so busy taking tickets that he did not have the time to pay the proper attention to running the train.

In other words, it is the experience of one of the largest and best equipped railway systems in the country that accidents are largely due to false economy on the part of railway managements in overworking its officials, and as a result of this experience, it has issued orders relieving conductors on excursion trains of all duties save those of preserving the lives, properties and interests intrusted to their care. The moral finds an application in more than one instance and nowhere may the principle involved find more timely adoption than in many electrical industries, notable in street railway work.

Not long since, the superintendent of a large Western railway system made the contention that a man who is accustomed to the use of air brakes, for instance, is less fit to meet an emergency in street railway work than is the man who has always stopped his car by the dint of muscle and the lever brake. The contention was, in brief, that the system which uses modern devices for the control of its cars is more liable to accident than the one which has the time-tried hand breaks, the dash-board fender and the appliances that have for years been part and parcel of street railway equipment. It was maintained that the motorman who has old-fashioned, yet reliable devices, realizes at all time that they are inadequate to meet every emergency, with the result that he trains himself to foresee emergencies and to avert them. His keenness and sense of perception of threatened danger is whetted and (so the theory went) in time of peril it is more safe to rely on a sound judgment than on a patented mechanism. As a result of these convictions, the road in question remained wedded to the old ideas, but it should be added that it is overwhelmed with damage suits for personal injuries inflicted on its patrons and the public. A deduction from this false mode of reasoning is that it is a mistake to relieve a motorman of the arduous duties that fall upon him and if this conclusion is not borne out by the words of the official referred to, familiarity with the road itself will certainly substantiate it. The men are overworked and underpaid; above all they are uncomfortable and accidents are not a cause of wonder.

Electric railway practice nearly approaches that of standard steam roads in many lines and the experience of the latter, being far more ripe, deserves the respectful consideration of the former, hence when a pioneer among trunk lines announces that the best preventive against accident on trains carrying large numbers of passengers is to lessen the duties of the man in charge, the advice should not be lightly heeded. The lightening of duties is but a another name for making a man more comfortable and as contentment comes with comfort, so the most perfect service can be attained only when employes are skilled, faithful and contented. Of these, contentment is the too-frequently-over-looked factor, but it is indispensible.

Here rests the secret of the greatest security from accident: Underwork rather than overwork the men who are custodians of corporate interests, make them contented even at the cost of satisfactory wages, the best of equipments and the most reliable of safeguards, or otherwise the expense of damage suits will o'er topple the preventive investment.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

THE PRINCIPLES OF THE TRANSFORMER: By Frederick Bedell, New York; Macmillan Company, 1896. 8vo., 416 pp. Price, $3.25.

The books published during the past few years relating to the Electrical Engineering divide themselves naturally into two classes, viz: those intended for the aid of engineers and designers who wish to proceed at once with the construction of apparatus for plants, and those for students wishing to obtain their knowledge in courses and willing to proceed step by step into a complete command of the subject with well laid foundations. This work belongs to the latter class and in spite of an exceedingly sarcastic review written in one of the London papers by Dr. Felming, we feel compelled to commend it to such students as desire thoroughly to understand the subject of electrical engineering. The author does not pretend that the subject is here gone over for the first time and we conclude from its perusal that the last word has not yet been said concerning the design of the practical transformer, but that the book may be considered as a mature step in the understanding of both theory and practice. The work belongs properly in a student's course and leads easily to the understanding of such practical works as that of Dr. Fleming, which is otherwise difficult to read and more difficult to reason upon.

It opens with an elementary description of the various systems of transformer distribution; Chapter II, being devoted to notations and conventions, presents a formidable system of symbols and mathematical substitutions which are not ordinarily considered at the beginning of such a treatise though we see no reason to criticize such a collection of symbols especially as it guarantees a single system of lettering throughout the book which is often neglected by authors and becomes a serious source of confusion. Following this chapter the real subject of the theory of the transformer is taken up. Chapters III and IV contain the definitions and formulae of the magnetic circuit and the simple alternating current arranged together, but not discussed in a manner intelligible to an elementary student, they are rather reminders of what has been done and serve as reference chapters for the succeeding portion. When now we have the transformer itself discussed we find that the method is the one often criticized, considering the coefficients of self and mutual induction as constants and developing the ideal mathematical theory which of course has not a definite physical existence. This method is pursued on account of the fact that we have at present no mathematical power of discussing the complete case of the actual transformer with variable coefficients of self and mutual induction or with a magnetic circuit losing energy by hysteresis and foucault currents. These quantities are finally introduced in the chapter devoted to the design and construction in which practical cases are indicated. It seems to be a serious defect in this portion of the book that the case given does not conform to the best practice of modern engineers and no data is furnished which will enable the student to form an opinion of what is the present practice in design. To be sure, such data is difficult to obtain, but it cannot be said to be entirely inaccessible and as such would have properly been here included. The method of winding described with copper strips cut from sheet metal is not only contrary to actual practice but is impractical on account of the actual difficulty of insulating over the sharp edges of such cut strips. This point may perhaps be considered unimportant as any definite strip may be rolled from a round wire, but the presence of the statement in this book that such strips are used shows the author to be unfamiliar with prevailing engineer practice.

In the final chapters on the experimental determination of transformer diagrams and transformer testing the same academic character of treatment is noticeable, practical results being almost entirely lacking and the most practical methods insufficienly described. This is especially to be regretted as Professor Fleming has carefully gone over the subject of transformer testing and has shown by practical examples the comparative accuracy of different methods, indicating the probable errors of the results in different cases and furnishing to engineers the data for a choice of a method for obtaining accurate results.

From these considerations, therefore, we should consider the book as an intermediate step for the student between theoretical works on alternate currents and the practical work of transformer design. The theoretical principles are here clearly considered and successfully worked out, though it is lacking as a definite guide to immediate practice.

SOME QUESTIONS ABOUT ELECTRICITY ANSWERED: By E. E. O'Daniels, San Francisco, John Partridge; 32 pp. Price 50 cents.

The author of this short pamphlet has aimed to write a primer which does not answer simply some of the elementary questions concerning electricity and its transmission, but endeavors to enlighten the unitiated concerning every detail of the subject including the nature of electricity, its production, the theory of alternating currents, the distribution of electricity, motor construction and operation, telegraphing and telephoning and electrolysis. These, surely, are not some, but all of the questions that might be asked by the inquisitive. In consequence, the primer might be read by one with full knowledge of the subject without finding many points on which to disagree with the author, but to such a person the pamphlet could have no value whatever while the unitiated enquirer would be sadly confused in following the author in his rapid sketch of the subject and would find little profit

in perusing these pages. The attempt is not as absurd as that of Nystrom who attempted to explain electricity to mechanical engineers by calling volts, millimeters, and amperes, grams, but at the same time while the information contained may not be criticized as misinformation, the pamphlet must be classed with the books which are of little use and pleasing mainly to the author. The practical man without time for a complete study of electrical action can better employ the time at his disposal in learning thoroughly the elements of the science than he can by running hastily over all the details of electrical applications as explained in this pamphlet.

Descriptive Catalogue of the Institute for Home Study in Engineering. Scientific Machinist Co., Cleveland, Ohio.

The Scientific Machinist Company of Cleveland, Ohio, has established a correspondence school for the study of three engineering subjects; a complete electrical engineering course, an electrical course and a course of mechanics and steam engineering costing for each student in tuition, respectively sixty, thirty-six and thirty dollars. The courses, while begun as an outcome of the technical instructions given at the World's Fair, have followed the lines of the Meisterschaft system of instruction by lesson, leaves and correspondence between the instructor and the scholar.

The particular difference between these and other correspondence schools being apparently in the fact that the scholar of this school retains a copy of his answers to questions, and at the same time forwards a copy to his instructor, and also that the school requires that a certain amount of apparatus be purchased, experiments made and mechanical work to be done. The total amount of apparatus required in the electrical engineering course costs some $60, thus making the entire cost require an expenditure of $120 by the student. There is no doubt but that $120 is insufficient for a year's study in any technical school, and consequently if we should consider the course to be of as great value as a year spent in a technical school, there is a decided advantage to the student in following this system of instruction. Even aside from the comparative value of such a correspondence course and any school course, there is much to be gained by instilling habits of home study and to the mechanic having the money to spare and the time to profitably follow the course at his disposal, much help can be obtained from this system of instruction provided the system itself furnishes a course sufficiently elemetary and well enough adapted to the needs of the prospective scholars. In the catalogue before us there is apparently too much of an attempt to cover a wide ground rather than to lay a foundation for future study in a thorough manner. The case itself calls for such superficiality on account of the fact that scholars would be less easily found for an elementary course requiring close study as for a more superficial course apparently embracing the whole field of any one branch of engineering. In order to avoid errors in teaching with such an extensive outline the instructors must of necessity follow only the well beaten paths and instruct by a method of describing what has been done rather than by explaining the fundamental ideas which led to engineering practice and which in some cases will ultimately bring about revolutions in existing practices. Here lies the disadvantages of teaching in the method of correspondence schools; after following their courses mechanics still remain mechanics and though they are undoubtedly better able to understand everyday practice, they form a conservative element in practice which tends somewhat to hinder the introduction of new ideas.

The names of the instructors who have written the lesson leaves for these courses warrant a careful preparation of the initial lessons but we fail to find in the catalogue the names of any of the examiners who pass upon the answers to the questions; while we would think that the success of the scholar would depend upon these examiners as much as upon the original writers.

The company operating the school is a responsible one and there is no doubt but that their promises will be fulfilled as far as it is practicable for them to do so.

MINE THORIUM AND MAKE MONEY.

The rare metal, thorium, discovered by the great chemist, Berzelius, early in the present century, has just had a singular commercial resurrection. Thorium is a rare earth that has long been simply a laboratory curiosity. When burned it emits a light more brilliant than that of burning magnesium, but until the recent invention of incandescent lamp-burners, in which the flame is encased in a metallic mantle, no use was discovered for it. Upon experimenting with various substances, it was found that the oxide of thorium, called thoria, makes the best mantle for such burners, and, a demand being thus created for it, the value of thoria suddenly sprang from almost nothing up to $250 a pound. Then a search began for new sources from which thoria could be obtained, and the search is not yet finished. Berzilius found it in some fragments of black marble in the island of Lowen, in Norway. The mineral which he found was known as thorite. It contains thoria, or the oxide of thorium in combination with a certain amount of silica. Thorium was afterward found in certain stones in the Ural Mountains, and especiallly in monazite, a mineral which is largely found in the United States and Canada, usually in the sands and gravels of small streams in the form of yellow crystals. These monazite stones are now being shipped in large quantities to England and Hamburg from Brazil and Bahia. On arriving at their destination, they are carefully sifted for the grains of the very precious and rare mineral which is now in such request. The price of thoria is now much lower than it was at the first rush of the demand, but it still commands $15 or $20 a pound, according to the state of the market. It offers a singular illustration of how a worthless substance may by the springing up of a commercial need, become one of the most valuable treasures which the earth contains.

Electro-Economics

LITTLE ECONOMICS IN CENTRAL STATION PRACTICE.

By Thos. G. Grier.

A number of letters have been written to central station men for suggestions on this subject and the paper as presented will be mainly a compilation of the points given in this correspondence.

A Superintendent from the far West writes: "My experience is, have a man in charge of your plant whom you can trust and who knows his business, pay him what he is worth, then having such a man, impress upon him to practice such 'little' economies as keeping his machines covered while not in use, keep his oil exits well guarded by dashes and oil-pans, have a place for everything and everything in its place; remedy a defect while it is small and don't wait until he has to; have a good oil filter and use it. There are a hundred other small things that will in the long run amount to a great deal more than a person would think."

Two men from different parts of the country write that ashes or cinders can be sold, as they are good for roadways and filling; one of them states that his company receives twenty-five cents a load for ashes.

The wetting of coal is for the purpose of laying the dust and it should not be carried to excess, as all the superfluous water has to be evaporated and uses up so much fuel without doing any good. One man writes that fifty of sixty dollars spent for a platform scales for the boiler-room will, if intelligently used in weighing coal and cinders, soon pay for itself and teach one the most economical fuel for the purpose.

Several engineers write that they get the best results from their fuel by firing light and at frequent intervals. Another advises against forced firing, as it may damage the brick work of the boilers by forming clinkers. Automatic fire doors, which are easily opened and close themselves reduces to a minimum the amount of air rushing over the top of the fire.

A good fireman is an investment that pays, not only in the fuel he may save, but in the care which he will give to the apparatus under his charge.

All water contains impurities which may form scale —a thickness of 1-16th of an inch will increase the demand for fuel for the same results about 10 to 13 per cent. For this reason it is economy to either use a mechanical purifier or ascertain what chemical reagents (boiler compounds) will neutralize the scaling effect of the water. It is economy to keep boilers clean.

Feed water heaters are recommended and perhaps would come under the head of large economies. One man states that the introduction of a heater made a saving of over 10 per cent in fuel.

Pumps should be examined; the packing becomes worn and instead of pumping water they churn it. Leaks in water pipes may not be much, but should always be attended to. In one case where the leaks were in a cheap heater, the water meter from the city mains showed 121 cubic feet per hour, and another meter on the boiler showed only 98 cubic feet, making a loss of 23 cubic feet.

An engineer of considerable experience says that the water when pumped into the boiler so as to maintain a uniform height at all times, gives the most economical results. He also advises covering all live steam pipes; all pipes to have as few turns and to be as short as possible, and never permit the smallest leak. The same opinion was also expressed by others, one stating that enough steam to run a ten horse-power engine was being lost when he first took the matter in charge.

I will quote from a letter: "Since putting the plant in this village, ——, we have had considerable trouble with our engine, and when your engine don't work right, everything is turned upside down, it takes twice as much oil and more coal to run it."

Another letter reads as follows: "It is well to look into the condition of the valves of high speed engines; many of this type have piston valves which are very seldom tight after a year's use. We have a 40 H. P. engine which was originally in a Chicago restaurant, the steam consumption of which was cut down almost one-half when a new valve was put in."

Leaks about piston or cylinder means expense, and applies equally to any make of engine. The adjustment, also, of a valve is a matter of consideration.

Quoting again from my correspondence: "The use of oil appears to be a small item in a small plant, but there is a good chance of economy there. We now use one-fourth the lubricating oil we did some months ago." This plant has been using an oil filter for two months. I find that every plant that has used an oil filter advise others to do so. One company have a home-made filter of sawdust and charcoal; others have different patented devices.

The secretary of a well equipped station writes:

"Our plan of oiling dynamos is as follows: We have an oil reservoir from which overhead pipes run to each machine. The pipes extend downward and have an opening directly over oil cups; this makes clean work and is very convenient. We have two good filters and all oil is filtered over and over again. We have had this simple rig in use about two years and it reduces the expense for oil and waste one half. In February the entire expense for oil and waste was $7.35 for the following machinery: 2 each a 60 and a 120 k. w. alternator, 5 50 light arcs, one 90 and one 150 k. w. generators, with all shafting, clutches, etc. The expense for oil is less than $100 per year."

Another station manager writes: "I think the most saving made is in using an oil filter. With 17 arc dynamos, 3 alternating dynamos, each with separate exciter, and one 50 H. P. generator we use three barrels of oil per year. Ten of the arc machines run all night and one incandescent dynamo day and night. A good oil will stand filtering a number of times."

Oil out of place is not a good thing; one spot of oil or grease on a pulley makes the pull of the belt less. One central station reports that this cause made it impossible to keep their dynamo up to voltage until discovered and remedied. The tension on the belt, if released when the dynamos are not running, increases the life of the belt. Observe carefully the tension on the belt when the dynamo is running, as too great a tension deteriorates the belt, defects the shaft and heats the bearings.

Cleanliness decreases expenses, makes accidents less frequent, and should be strictly enforced. Dirt is a great enemy to electrical machinery and instruments and a cause of fire.

A good method of cleaning dynamos is employed in a station in Wisconsin and might be adopted by others with profit. A pump forces air into a small compressed air reservoir; from the reservoir small pipes run to the dynamos. There are valves near each ma-

chine. A small rubber hose with a nozzle is attached to any pipe, and in a minute the dirt in or on the machine can be blown away. This cleans parts that cannot be reached by the hand and saves repairs.

Two stations give suggestions in regard to brushes. One states that on their arc machines they use two five-fingered and two six-fingered brushes on the commutator, which makes the wear even, no ridges being cut in the commutator.

Certain types of dynamos have carbon brushes bearing strength or end on the cummutator. The springs which feed these brushes come to the end of their travel while 1½ inches of the brush is still left. One electrician writes: "We added an extension on one half of all the springs in the station and transferred the partly worn brushes into a position underneath these springs, giving an additional ⅝ inches wear thereby. This amounts to a saving of 9 cents per day."

"In the matter of carbons, we have found that by putting a stop in the upper carbon holder, so as to prevent the insertion of the carbon any further into the holder than is absolutely necessary to make it secure, we can eliminate the irregularities of adjustment by different trimmers, and thus can burn the carbons to the last quarter of an inch, without danger of any lamps being extinguished before daylight by a short supply. With this device we combine a slight reduction of the current after midnight, just enough to keep our double carbon lamps at the normal voltage instead of permitting them to burn high, as such lamps do if the current is kept full during the latter part of the night. The result is an economy of $3 per day in carbons as against the corresponding lighting hours of last fall. The stop appears to be a trifling item, but it secured the certainty of carbons lasting the calculated time."

Up to a year ago another company used 12-inch carbons only and for the lower carbon the trimmers were compelled to break the 12-inch carbon in two, the result was that much was wasted; they now use 7-inch and 12-inch and find it a saving. High grade carbons for arc lights in stores are found to give better results. In a station having 400 street arc lamps that run all night, during the months of May, June, July and August the lamps are trimmed every other day.

By patrolling all outside circuits at least once a week, grounds and short circuits will be forestalled and rebates saved. One station having a large number of city lamps has two night inspectors who patrol the circuits in wagons and carry a couple of lamps with them to replace any that are not burning, thus preventing a rebate to the city.

Mast iron rope is being substituted for manilla rope in a number of instances. Where live wire passes through trees one plant has fastened a wooden covering securely to the wire, thus saving the wire and the currents. Trees are a constant source of grounds, and tree insulation is a matter to be carefully considered.

Where the arc light wires come to the small arm just over the head of an arc lamp and are fastened to the insulators the wire sometimes breaks. To prevent an open circuit from this cause, an engineer in Wisconsin reinforces the wire at this point by joining a short piece of wire to the main wire several inches each side of the insulator, making a sort of a bridge or by-pass for the current.

A method for increasing the life of a pole is used in a plant in Illinois. A length of sewer pipe, the cheapest call will answer, is slipped over the pole about to be set, after raising the pole adjust the pipe so that two inches of it will be above the surface of the ground, and fill in between the pipe and the pole with cement or grout. This keeps the moisture away from the pole. The pipe and cement cost about 25 cents per pole.

"The greatest saving known in the running of our plant has been through the introduction of meters," is the reply that came from a plant in Wisconsin.

Another says that close regulation or constant voltage saves many a lamp, and they save by guarding against irregularities in speed of machines and close attention to their instruments. Several plants considered the matter of regulation one in which a saving could be made.

A rather large station says: "From one o'clock in the afternoon until late in the evening we keep a boy at a dynamo regulator on our incandescent dynamos in order to regulate the pressure on the lamps. We do not depend on the station instruments for this regulation but have run pressure wires back from the center of distribution of our different feeders and put indicators at the end of the pressure wires. The Edison three-wire systems do it also, but few alternating systems are carrying it out. By doing this we more than save the boy's salary in our saving in lamp renewals due to the pressure being kept regular during the heavy burning hours."

A station of 3,500 horse power recommend employing a machinist by the year as a Jack-of-all-trades. They have purchased a pair of belt clamps and outfit for $18, have sent one of their men to a belt manufacturer to learn how to splice belts, etc. They also sent a man to the T. H. factory at Lynn, to learn how to wind armatures. They purchased a Wheatstone bridge for testing and are now doing all their repairs, from winding armatures and arc lamp magnets, to taking up the slack in their thirty or more belts. They use a mechanical watt meter and find that a saving is made by having the meters cleaned, leveled up and tested, as they frequently run slow.

They insist on running but one service to a building for incandescent lights and incandescent arcs, and the customer consequently has his wiring done so that both these kind of lights can be taken from one kind of service.

"On our system of 1,000 volts primary and 54 volts secondary where the heavy lighting is, we now run two 0000 wires the length of the block and put a large transformer either 150 or 300 light on each pole and tie the transformers together in multiple, thus displacing a number of small and inefficient transformers. The result is now not only economy in transformers but ease in running service."

A humming converter means a loss of energy, and if there is a great deal of humming the converter should be examined to see if there are not some loose parts that need tightening. Rubber washers under the feet of a converter will deaden the noise and perhaps quiet a kicking customer, which is economy. More economy is claimed for large transformers by the manufacturers.

The secretary of a successful station writes: "We have watt meters on our 500 volt power circuit, on our dynamos supplying current to the street railway and our alternating incandescent circuits. We take the amperes of every arc circuit once each week and the voltage of every arc circuit once each night, putting

down the time the arc circuits go on and the time they come off. In this way we know at the end of each month the number of kilo watts that we have manufactured and what portion each class of business bears to the whole.

"Accounts which are common to all classes of business are pro-rated against each class, depending upon the output of the station in kilowatts. Other accounts which have a direct bearing on each business are chargeable to that business. In this way we know at the end of each month how much is chargeable to each business, and what is the margin of profits."

There are "little" economies "in details." Here are a few short quotations from letters I received in response to my query as to little economies:

"The first to come to mind under your paper is discount all bills promptly, as your supply house can afford to give better prices when they know their invoices will be paid promptly."

"If furnishing street lights show your council and committee that you are trying to give the city all he contract calls for."

"Treat your customers as reasonably as possible, they will reciprocate."

"Collect all your bills before the 10th of the month."

"Keep the stockroom under lock and key and have supplies taken out on requisition; men get careless and this is a leak that foots up very fast."

"Bad joints, that is joints not soldered, and loose, are poor economy."

"The use of exhaust steam for heating in winter is economy."

Every plant in itself is a distinct problem and what may be economy in one may not answer in another. This paper in no way covers the subject—is simply a number of suggestions from men grappling with the problems of economy.—Read before the Chicago Electrical Association.

Reports of the Month.

TRANSMISSION.

Napa, Cal.—Richard Wylie has published a statement upon the utilization of water power at Clear Lake in which he states that from 5,000 to 10,000 horse power can be developed with but one mile of flume and that by building six miles of flume or canal a fall of 450 feet can be obtained, which will develop approximately 60,000 horse power. Mr. Wylie quotes from the reports of T. B. Stowden and G. F. Allardt appearing in the municipal records of San Francisco for 1874-75, on Page 632, showing that Clear Lake has a drainage area of 517 square miles with an average rainfall of 34.4 inches, 54 per cent of which for utilization supplies 110,656,000,000 gallons per annum, or 327,000,000 gallons per day. The elevation of the lake above tide water is 1,317 feet and the distance from San Francisco in air line is 75 miles. The area of the lake is 82 square miles; its depth varies from 40 to 150 feet; its length is 26 miles and the maxium rise and fall of the lake is 12 feet 6 inches. The Clear Lakes Electric Power Co., owns the water rights for Cache Creek, forming the outlet of Clear Lake, and it is held that the company has a market for power in all of the principal cities of Central California.

LITIGATION.

Tacoma, Wash.—Judge W. H. Pritchard, of the Superior Court, has decided the suit of the Commercial Light & Power Co. against the city of Tacoma, in behalf of the plaintiff. The Court holds that the complaining company fulfilled, on its part, all the conditions required of it when its franchise was granted; that the action of the council pretending to repeal that franchise was absolutely null and void; that the contract between the company and the company formally owning the city plant was valid and binding upon the city; that while notice in proper form terminating that contract was at one time served by the city, it subsequently accepted payment of rental which amounted to a waiver of that notice, and the city attorneys are held to have had full notice of this fact; that Commissioner Doherty's notice, subsequently given, was informal and invalid, and as a consequence that the action of Mayor Fawcett and his police in violently destroying the property of the company was in fact a riotious proceeding in every way, and of a character that renders them liable to punishment under a criminal prosecution. In thus holding, the court is sustained by the decision of the Supreme Court of Pennsylvania in the Appeal of Easton vs. S. E. & W. E. P. Ry. Co., which, in declaring city officials who tore up a street-car track to be "merely trespassers and rioters and liable civilly and criminally as such," emphasized that "it is a serious mistake to suppose that municipal officers are above the law and can enforce civil rights, or perform police duties, in their own way, in disregard of the forms of law. The officers of a municipality, from the mayor down to a police officer, are as much bound by the law as a private citizen, and have no license to transgress the law in the enforcement of the law."

Los Angeles, Cal.—The State Supreme Court, in the case of Frick et. al. vs. the City of Los Angeles, has upheld that section of the Los Angeles city charter which invalidates city contracts unless signed by the mayor. W. R. Staats of the West Side Lighting Company, has sued for a writ of mandate to compel the acceptance of his bid for an electric lighting franchise.

ILLUMINATION.

OAKLAND, CAL.—At the annual election of the Oakland Gas, Light & Heat Company, D. E. Martin was made President, John T. Wright Vice-President, and John A. Britton Secretary and General Manager, and these gentlemen, with Thos. Crellin and James Moffit, constitute the Board of Directors. ——The city has ordered the discontinuance of the moonlight system of electric lighting, and hereafter lights will burn all night and every night.

ALAMEDA, CAL.—The 250 k. w. Stanley two-phase inductor recently installed for the municipal plant by John Martin, Pacific Coast agent for the Stanley Electric Manufacturing Company, has been in regular service since first started up, and the incandescent lighting business of the city is now being rapidly increased.——The Municipal Ownership League is agitating the question of having the city install a gas plant, and has employed an expert to report upon the cost of erecting the same.——The Board of Trustees has passed an ordinance requiring all live wires to be placed underground before May 15, 1897, and stipulating that all new wires are to be put underground whenever installed.

CITY OF MEXICO, MEXICO.—The transmission plant of Toluca, built and owned by Hinkle Brothers, of that city, was formally inaugurated by the Governor of the State of Mexico on August 20th. The power house is situated at the foot of a snow-capped extinct volcano, the water being supplied from the melting snows. The pipe line varies from 18 to 22 inches in diameter, is 1750 feet long, and delivers water at a head of 230 feet to a high-duty Girard water wheel, manufactured by the Girard Water Wheel Company, of San Francisco. The transmission is about ten miles in length, and Westinghouse apparatus is used throughout.——Henry Adams, of South Bethlehem, Penn., is erecting an electric lighting plant at the Mexican National Railroad depot.——A 250-light isolated plant has been installed in the postoffice.

BERKELEY, CAL.—New Directors of the Berkeley Electric Light Company have been elected, as follows: President, John Britton; Vice-President, Anson Blake; Secretary, W. Topham; Treasurer, Commercial Bank. Directors, John Britton, Anson S. Blake, J. J. Mason, A. T. Eastland and John T. Wright.——

Arrangements are being made for operating the plant of the Berkeley Electric Light Company by current brought from the plant of the Oakland Gas, Light & Heat Company, in Oakland, and an incandescent and arc circuit have been erected between the two stations, the Berkeley station to be used hereafter as a sub-station. In effecting the changes the Berkeley plant was shut down for a week or so, which gave rise to a report that the eighty-light Western Electric Arc dynamo in use in the Berkeley station had broken down. That this report is without foundation is evident.

ANAHEIM, CAL.—The Board of Trustees has adopted ordinance No. 114, declaring a determination to extend and complete the city water works and electric light plant, and have also instructed the City Attorney to draft preliminary ordinances calling for an election to vote upon incurring a bonded indebtedness of $15,000 therefor. The original plant was installed about a year ago, and the demand for electric lights is so great as to warrant the proposed extension. At present a 500-light machine is in use, and it is overloaded 20 per cent. ——Trustee Joseph Helmsen has published an open letter regarding the municipal lighting plant at Anaheim, from which it appears that the total investment in the municipal plant is $7000, payable, principal and interest, in forty annual payments. The commercial rates for incandescent service vary from 85 to 75 cents per 16 c. p. lamp per month, according to quantity for 9 o'clock lighting, and from $1.05 to 95 cents per lamp per month for 12 o'clock lighting. The meter rate for commercial lighting is 22 1-2 cents per thousand watts, and for residence lighting the rate of 15 cents per thousand watts.

TRANSPORTATION.

Healdsburg, Cal.—Supervisor Gray, who has been appointed a committee of one to investigate in detail the electric railway projected to connect the principal towns in Sonoma county with tide water, has expressed a favorable opinion of the project. From the specifications furnished by J. A. Griswold who is exploiting the scheme, it appears that the proposed line is to extend from Barkadero, a schooner landing at the southern end of the county, to Sonoma, Santa Rosa, Healdsburg and Knight's valley, connecting at the county boundary with the Napa system, which is to be constructed by the same corporation. Another line is run from Santa Rosa to Petaluma via. Sebastopol, going on to the coast near Duncan's Mills, thus the system will take in every point of importance in Sonoma county save Cloverdale. The plans propose the laying of 100 miles of 3½ foot gauge using 40 pound rails and the prospectus estimates the cost of the road at $7,000 per mile. The road will be operated by electricity obtained by water power at two different points of the system.

COULTERVILLE, CAL.—All preliminary surveys for the Mariposa Electric Power Company have been completed, from which it appears that the property of the company consists of a water location at the old Broad Bend dam on Merced river in Mariposa county, where it is proposed to erect an 85-foot dam and to conduct water by a flume seven and one-half miles to a point opposite the old Benton mills. The water at the lowest stage is 10,000 miner's inches and the fall at the power house is 225 feet in the clear. This will give, approximately, 6000 horse-power. The power plant will be in the center of the great mother lode of California, on which are many large and valuable mines, ninetenths of them lying idle for want of cheap power. Steam power in that locality now is costing $10.50 per horse-power per month. The company proposes to furnish power at $5 per horse-power per month. The cost of the installation is roughly estimated at $300,000, and bids for the construction are to be invited about October 1st.

OAKLAND, CAL.—John W. Treadwell, of the San Joaquin & San Francisco Coal Company, has given the following outline of the operation of the Corral Hollow transmission project: "It is proposed to use the coal screenings, which otherwise would go to waste," said he, "to generate the power. A large percentage of coal is wasted at all mines where there are no means such as this would be to utilize the fine material. Mr. Richardson is President of the Pacific Transmission Company, as the company organized for utilizing the screenings is called, and Dr. Addison of the General Electric Company is also working upon the enterprise. When the power line is constructed it will pass through Oakland in reaching San Francisco, although a branch will be run to this city. The shortest practicable route to San Francisco will be sought, and it will be by way of Haywards canyon, thence to the bay shore opposite Hunter's point, and by cable across the bay. It will be about thirty-four miles from San Francisco to Livermore by this route, and ten miles more to the mines, or forty-four miles in all."

Riverside, Cal.—The Arlington Street Railway Company has agreed to purchase from the city electric power for the operation of its proposed electric railway system at the following terms: The city is to install a 75 horse power transformer and furnish 80 horse power in 3-phase current to the railway company on the following terms: For the first three years, $500 per year; for the next two years, $1,500 per year; for the next three years, $2,400 per year; thereafter $2,700 per year. Less power than 80 horse power will be paid pro rata. If more than 75 horse power is needed by the road, the company will be obliged to put in another transformer and additional power, to 75 horse power, and will be furnished at $4 per horse power per month. The contract is contingent on the ability of F. A. Miller to place $75,000 in bonds and spending $100,000 in equipping the road with electricity. The life of the contract is for 12 years, with a possibility of extention of time for 20 years longer, or a total of 32 years.

San Francisco, Cal.—The following officers were recently elected at the annual meeting of the Sutro Railroad Company: President, Adolph Sutro; Vice-President, O. F. Von Rhein; Secretary, Theodore Krause; Treasurer, the American Bank and Trust Company; Superintendent, E. M. Van Frank...... The Market Street Company is now operating the new electric lines on Fourth and Folsom streets.......Alexander McAdie, Chief of the Weather Bureau has called attention to the necessity of equipping the street railway systems and cars in California with lightning arresters.......The reorganized San Francisco & San Mateo Railway Company proposes to extend its lines in several directions, principal among which is an extension by way of Sunnyside avenue to Ingleside; also, the road will be extended from Baden to San Mateo, seven miles; also, from Baden station to the South San Francisco stockyards, two miles; also, from the present Steuart-street terminus to the ferry; along Market street, if practicable—if not, on Mission from Steuart to East and thence to the union depot.......The Presidio and Ferries Railway Company has at last begun work on converting its Union street cable line into an electric system.....The power house at the junction of Bryant and Alameda streets is to be furnished with two more engines. When they are in position the concern will have a capacity of 4,800 horse power in Siemans Halske generators and Union Iron Works engines, which is sufficient to operate all the electric street railroads now being or likely to be constructed by the Market Street Railway Company. The Carl-street electric power house will then be abandoned, and the site sold in building lots. The transformation of the Howard and Post street routes from cable to trolley lines will at once follow, and then the several roads which run west from the northerly line of Market street will be brought under the electric system, one after the other—all being operated from the power house at Bryant and Alameda streets.

The Market Street Company will have its Mission street line in operation to the county line by October.......It is reported that an electric railway company is about to be organized for building an electric line between San Francisco and San Jose, a distance of 52 miles.

ELECTRIC POWER FOR THE TWIN CITIES.

The contract for the electrical utilization of the Falls of St. Anthony at Minneapolis has been awarded to the General Electric Company. It will be remembered that the St. Anthony Water Power Co., and the Pillsbury flour mills and elevator lines were merged into the Pillsbury-Washburn Flour Mills Co., which controlled not only most of the developed water power of the Falls, but also the undeveloped water power below the Falls. A dam to utilize this power was constructed and the total available is calculated at 10,000 H. P.

The water will pass through seven turbines, each of 1000 H. P. capacity and which will form the initial hydraulic equipment. The electrical equipment will consist of a plant comprising both direct current railway apparatus for the needs of Minneapolis, and three phase apparatus for transmission of part of the power to St. Paul. ten miles distant.

The direct current portion consists of two 700 K. W. General Electric multipolar generators, with a speed of 130 revolutions per minute furnishing current at 600 volts, and two 100 K. W. exciters for the three phase alternators. The three phase generating plant consists of five 700 K. W. alternators with a frequency of 35 cycles, and an initial voltage of 3450 volts. This pressure will be raised to 12,000 volts in six step-up transformers of the well known air blast type, and at this voltage the current will go to St. Paul either by overhead or underground wires. This has not yet been settled. At St. Paul the pressure will be reduced in 15 step-down transformers, when the current will be led into five rotary converters of special type. They will resemble in appearance those which the General Electric Company has installed in the power house of the Buffalo Street Railway Co., to take care of the power transmitted from Niagara Falls. They are 8 pole machines, each of 600 K. W. capacity, running at 520 revolutions and turning out direct current at 580 volts. They are designed to operate in parallel with each other, or with the generators now driven by steam in the existing station. The water power development and the electric plant completed by the Pillsbury-Washburn Company will be operated by the Twin City Rapid Transit Company, a lease having been made between the two companies to that effect. The Street Car Company will send to St. Paul about 3000 H. P. leaving 4000 H. P. to be used at Minneapolis.

When the new power is set to work running the street cars the street railway company will dismantle the Thirty-first street power station, using the room for other purposes. They will continue the main power station at Third Avenue north and Second Street, and also the power station in St. Paul. These will be kept ready for emergencies, such as a break down, a sudden call for extra power and similar occasions. In case there is water enough and conditions are favorable there are still three more units to be installed at the dam.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Flec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

The Journal of Electricity

Vol. III. DECEMBER 1896. No. 6

A Modern Fire Alarm.

Stockton, California, not only enjoys the distinction of being the first city on the Pacific coast to equip its fire-alarm system with storage batteries, but it may also lay claim to having one of the most modern installations of this class of service to be found in the country. The plant throughout is of the latest type of fire alarm equipment made by the Gamewell Fire Alarm Telegraph Company of New York, which embodies a number of distinctive features. The equipment proper consists of twenty-four Gardiner non-interfering boxes, one three circuit repeater, together with three 15-inch, one 8-inch, and six 6-inch combined gongs and indicators. In addition, a repeating box, as illustrated in Figure 3, is installed in the telephone office.

It has been the aim of Mr. R. A. Rose, Pacific Coast Agent for the Gamewell Company and under whose direction the system was installed, to make the Stockton plant entirely automatic in every detail and so thoroughly has this been accomplished that unmistakable notification of any irregularity or of possible unsatisfactory operation, is always at hand. The main features of any fire alarm system are shown in the construction of its switchboard, and the illustrations herewith presented bring out to the fullest degree all information that may be required concerning the operation of the plant. The only difference existing between the equipment installed and that originally designed consists in the fact that a four-circuit board has been installed, while a six-circuit switchboard is

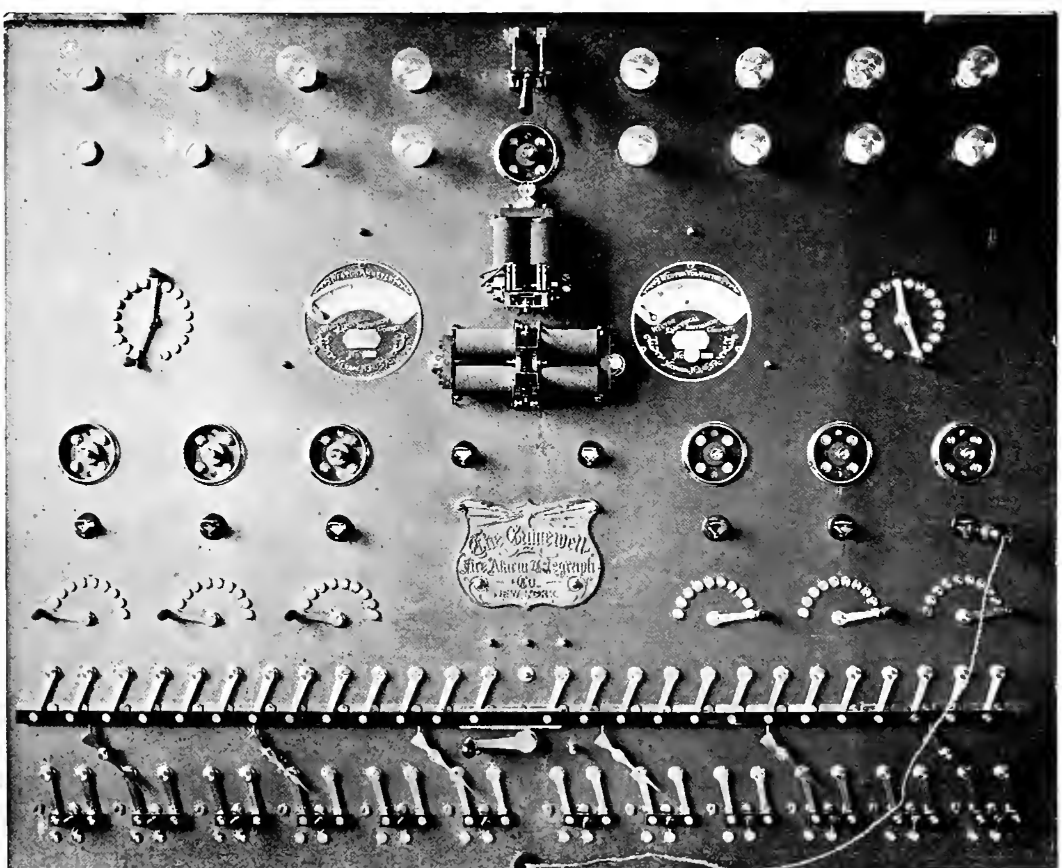

Figure 1.—Front View of a Modern Fire Alarm Switchboard.

reproduced. The switchboard is of solid slate, measuring five feet in width, by four feet in height by 1½ inches in thickness, and on it are the various instruments whose functions are about to be described.

The storage battery is arranged in two series, each consisting of sixty type "D" Chloride Accumulators, having a capacity of six amperes at about 125 volts for twelve hours. These series are charged on alternate days, that is series "A" is charged on one day, and series "B" on the next day and so on. The charging current is available eighteen hours daily and is taken from the 500-volt power circuit of the Stockton Electric Railway Company, and the voltage is cut down through the lamp resistance and the rheostatic resistance shown, to sixteen-one-hundredths of an ampere. The rheostats advance in twenty-ohm steps. Each battery is charged in series and during discharge, the cells are connected to separate line circuits and the line resistances are balanced by means of the lower rheostats which, like the upper ones, advance by twenty-ohm steps. All circuit details will be readily comprehended by reference to Figure 2, illustrating the switchboard connections.

FIGURE 3.—THE REPEATING BOX.

The two series of accumulators are designated as battery "A" and battery "B" respectively, and while one series of cells is being charged, the other series is operating the fire alarm system. A single series of battery carries the whole system for twenty-four hours on one charge and that the working rate is well within the capacity of the battery is clear from the fact that the discharge rate varies between eight one-hundredths and nine one-hundredths of an ampere, never exceeding the latter quantity.

The Weston ammeter shown on the switchboard has a capacity of one ampere, and is readily readable to one one-thousandth of an ampere. The ammeter and voltmeter are connected to the three-cornered plug shown by a flexible cable and the circuits are so arranged that on inserting the plug into either of the receptacles designed for it, the voltage and ampereage of the circuit so plugged is shown on the instruments.

The charging current enters the switchboard by means of the double pole, single throw break switch at the top of the board, whence it continues to the circular double pole fuse block immediately below and which carries a one ampere fuse. Close beneath the fuse block is an automatic magnetic cut-out, by means of which the charging current is broken on the occurrence of any abnormal condition. If the polarity of the charging current becomes reversed from any cause, prompt notification is given by means of the polarized relay immediately beneath the automatic cut-out, which rings the six-inch vibrating gong shown on the back of the switchboard. After passing through the three-cornered receptacles for the plug for the Weston instruments, the circuits continue to the gang and parallel switches, by means of which the desired combinations between battery and lines are effected.

An interesting feature of the Stockton system, and one which is rapidly coming into general use in the progressive cities that contain modern fire alarm equipments, is the repeating box illustrated in Figure 3. As stated, this box is placed in the telephone exchange and its function is to permit the telephone operator, upon receiving notification of fire by telephone, to send in a regular alarm from the box designating the district in which the fire exists. How this is done will be understood by reference to the illustration, which is shown to consist of a cabinet containing a number of character wheels which are exact reproductions of the character wheels in the street boxes. The mechanism near the top of the cabinet is the same as that contained in each street box with the exception that it is actuated by the operator, who, in sending in an alarm, throws the lever down around to the right and releases. The lever returns to its normal position, and in doing so, it rings in on the circuit whatever box number is indicated on the character wheel that the operator has first placed in the mechanism. The repeating box contains merely an ordinary street box mechanism with interchangeable character wheels, but by installing it in a telephone office, as is done in Stockton, the scope of usefulness of the fire alarm system is enlarged really to the extent of making a fire alarm box of every telephone in the city.

The claims of a patent are required to be so stated that the public may know what they are prohibited from doing during the existence of the patent, and what they are to have at the end of the term as a consideration for the grant.

THE SMITH MANIFOLD CALCULATOR—III.

By Geo. P. Low.

It is now well to proceed to the various classes of problems heretofore outlined as being solved by the Smith-Manifold Calculator and first, to take up the three functions of a simple circuit as treated by Ohm's law—the fundamental equation of the science of electricity, viz:

$$C=\frac{E}{R}$$

Or, the amperage (C) of a circuit of known voltage or electro-motive-force (E) and resistance (R) is found in the quotient of the numerical value of the voltage, divided by the numerical value of the resistance. Thus, if 1500 feet of number 28 copper wire, having an approximate resistance of 100 ohms, be placed across a circuit of 110 volts, the amperes which will flow through the wire will be found in the quotient of 110 (E) divided by 100 (R) or, 1.1 amperes (C).

By transposing the terms of the simple equation symbolizing Ohm's law, as above, it is also found that the electro-motive fore, or voltage, of a circuit of known current and resistance is always expressed in the product of the amperage multiplied by the resistance: $(E=C\text{x}R)$,

While the resistance may always be derived by dividing the electro-motive force by the current in amperes, thus:

$$R=\frac{E}{C}$$

Evidently then, this inter-relation of the functions of an electric circuit prevails in every use to which current may be placed. For present purposes it may be considered as a universal and all pervading rule but strictly speaking, it does not represent the exact conditions existing in circuits of alternating currents which are governed, according to conditions, not only by Ohm's law, but also by laws variously known as those of mutual and self-induction, reactance, impedance, the separation between wires, the angle of lag, the power factor and what not else. All of these functions, which are peculiar to alternate or polyphase currents, apply most particularly to long and high potential circuits, hence it is well to entirely overlook them at this time, more especially as they do not in any instance exert an influence within the sphere which the Smith-Manifold Calculator is designed to cover. In the wiring of a building to be lighted from a transformer or other source of alternate current, the circuit conditions are so similar to those existing in lighting the building, however large, by direct or continuous currents that the actual differences are hardly susceptible of measurement. In practice, therefore, no distinction is ever made in wiring a building to be lighted

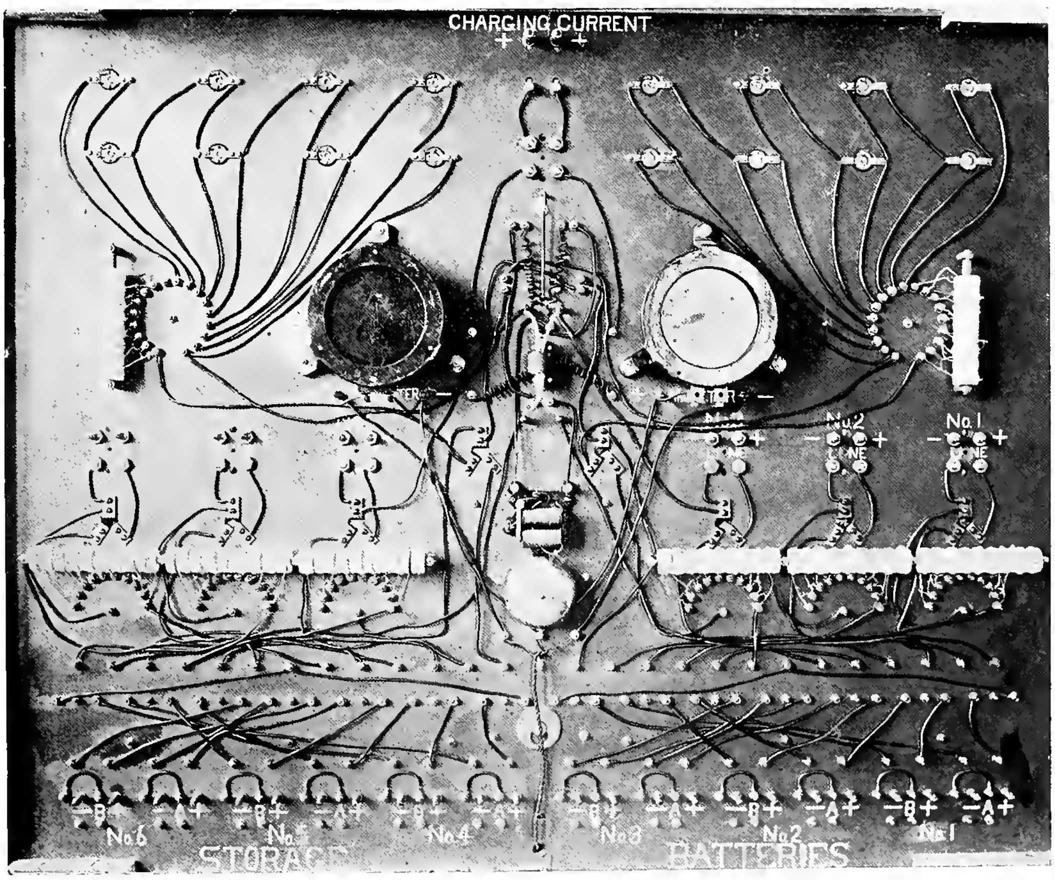

Figure 2.—Rear View of a Modern Fire Alarm Switchboard.

by direct or alternating currents, hence again it is unnecessary to draw a distinction between these two systems of distribution for the uses to which the Smith-Manifold Calculator may be put in the solution of wiring problems.

In the early days of electric wiring, those that did not wire by "guess" calculated the size of the circuits by Ohm's law, and many yet adhere to that method. It is accurate, though less direct than the modes now in use, and its use simply consisted in determining the resistance that a wire of given length must have in order to give a desired drop or loss in volts.

Seventh Example: A lamp circuit of 20 amperes is to be run a distance of 348 feet from a storage battery operated at a potential of 100 volts. Required, the size of conductor for the circuit, the permissable loss in volts being 7 per cent.

Seven per cent. of 100 volts is 7 volts, hence it is required to find the resistance of 348 feet of wire that will carry 20 amperes so that the difference in potential between the two ends of the wire will be 7 volts. Ohm's law shows that the resistance equals the voltage divided by the current, or 7 (E) divided by 20 (C) which is .35 ohms, the required resistance. It is necessary to refer to a table of resistances of copper wires to ascertain the size of wire that will have a resistance of .35 ohms in a length of 348 feet. As resistances are given in "Ohm's per 1000 feet," obviously 1-348th of .35 multiplied by 1000 will give the resistance of the required size of wire per 1000 feet. In this instance, the resistance thus derived is 1 ohm or, as a resistance table will show, practically a number 10 B. & S. wire, which is the size required.

It is thus seen that the application of Ohm's law forms a round-about way for solving wiring problems and it is not surprising that it is now seldom used. To those who are still wedded to it however, the Smith-Manifold Calculator will prove of service in that it will tell at a glance the resistance necessary—that is, it will serve this purpose until the user realizes how far more simple is the direct reading of the size of wire from the scale itself. Nevertheless, other problems, such as the determination of resistances for rheostats, or the derivation of the size of wires for field coils and all uses in the line of simple circuit relations must invariably be solved by Ohm's Law.

In resolving the functions of Ohm's Law by the Smith-Manifold Calculator, the circular mils scale is read as voltage, that is, for 110 volts read 11,000 circular mils or 110,000 circular mils as is most convenient, remembering that as you have multiplied by 100 or 1,000, as the case may be, you must in the final result, compensate by the same amount. Similarly, the resistance in ohms is read on the feet-one-way scale, while the amperes are read direct on the ampere scale. If now it is required to find the resistance of a wire that is to carry 20 amperes with a drop of seven volts, place the arrow indicated "C" and appearing on the volts-lost scale, opposite 7,000 on the circular mils scale (i. e., 7x1000), as in Figure 3, then over 20 amperes appears 348 on the feet-one-way scale. This would be the solution of the problem were the required resistance 7000 ohms, but as it is 7 ohms, obviously the resistance required is .348 ohms. Again,

Eight Example: What resistance is required to give a current of 15 amperes across a circuit of 245 volts.

Upon proceeding to place the constant or "C" arrow upon a multiple of 245, by 100 say, it is found that the resistance—the feet-one-way scale has been drawn to the right beyond the 15-ampere mark, but the apparent inadequacy of the Calculator is easily rectified by reversing the slide, to do which any point on the volts lost scale—say 10—and observe the reading opposite it. In the present case the reading opposite 10 volts lost is a trifle under 53,000 circular mils. Now move the slide to the left until one volt lost is opposite 53,-

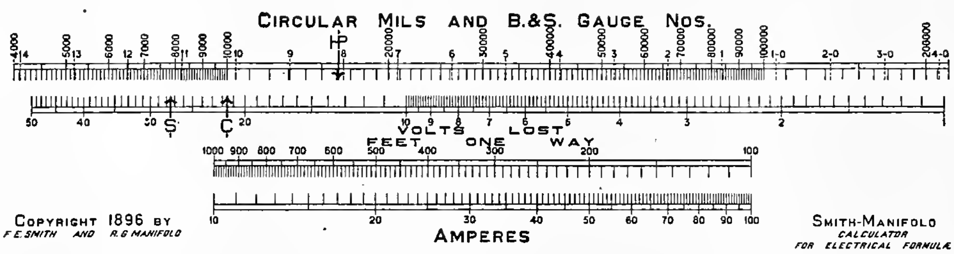

FIGURE 1.—THE SMITH-MANIFOLD CALCULATOR.

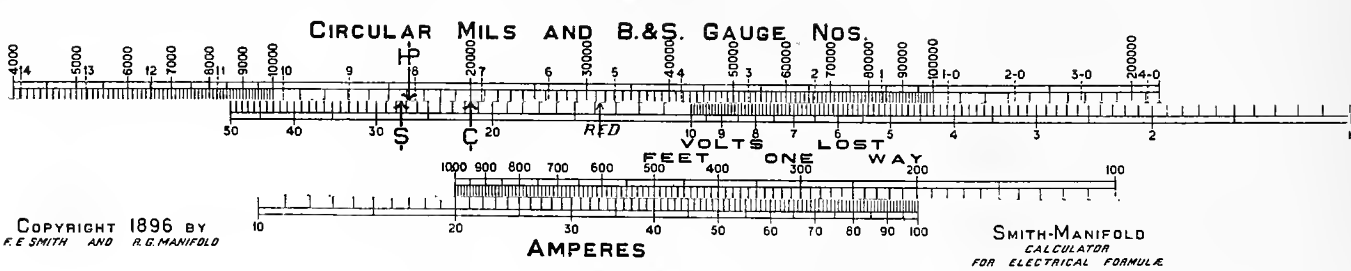

FIGURE 2.—THE SMITH-MANIFOLD CALCULATOR.

000 circular mils and the calculator will appear as in Figure 4, while the result of reversing the slide as done in drawing it to the left will be simply dropping a cipher from the circular mils reading or dividing by 10. Over 15 ampere now appears 163 ohms, but in reversing the slide the result was divided by 10, hence it is only necessary to divide by 10 again (as the assumed multiplier was 100) which quotient now shows the resistance required to 16.3 ohms.

This and other processes in the use of the Calculator may, at first glance, appear cumbersome and confusing, but it forms one of those occasions wherein the perfect application may be grasped in a second, or, as is more often the case, it will appear ambiguous at the outset and then, quick as a flash, a single idea becomes seated which clears the whole understanding. As stated, the ease and rapidity with which the Smith-Manifold Calculator solves problems is marvelous and after one has acquired the knack of using it he finds it to be a most interesting and endless volume of practical wiring lore.

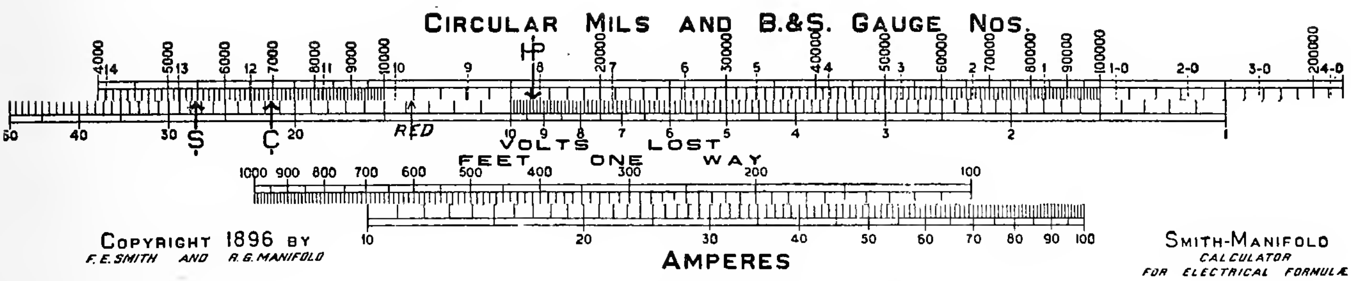

FIGURE 3.—THE SMITH-MANIFOLD CALCULATOR.

Naturally, the derivation of any factor of a circuit when the remaining two are given, is worked out along the same lines as in the seventh and eighth examples; for instance:

Ninth Example: What is the amperage taken by an electric heater having a resistance of 9.5 ohms when supplies with current at an electro-motive-force at 200 volts.

Place the constant indicated by the arrow "C" on 20,000 circular mils as in Figure 2 and under 950 on the feet-one-way scale read 21 amperes, the current required. In this it is evident that having multiplied 200 volts by 100 giving 20,000, the remaining factor of 9.5 ohms must also be multiplied by 100 to preserve equality, for multiplying both numerator and denominator by the same number does not alter the value of the fraction. Again:

Tenth Example: It is required to know the voltage necessary to drive a current of 30 amperes through a resistance of 6.66 ohms.

Set the slide as in Figure 2 with 30 amperes on the 6.66 mark on the feet-one-way scale, and then opposite the constant "C" read 20,000, hence 200 volts is the potential required.

It must be borne in mind that should any factor required be beyond either scale of the Calculator it is only necessary to reverse the slide as explained in the Eighth Example, in which event drawing the slide to the left divides the reading on the circular mils scale by 10, while drawing it to the right multiplies by 10.

To recapitulate, Ohm's Law is solved by the Smith-Manifold Calculator by the following:

Rule 1. Multiply the voltage by 100 or any convenient multiplier and place the constant indicated by the arrow "C" on the product thus obtained and as expressed on the circular mils scale, when the reading of opposite points on the feet-one-way and the ampere scales will respectively represent (1) the resistance in ohms multiplied by 100, or the convenient multiple selected, and (2) the amperes direct.

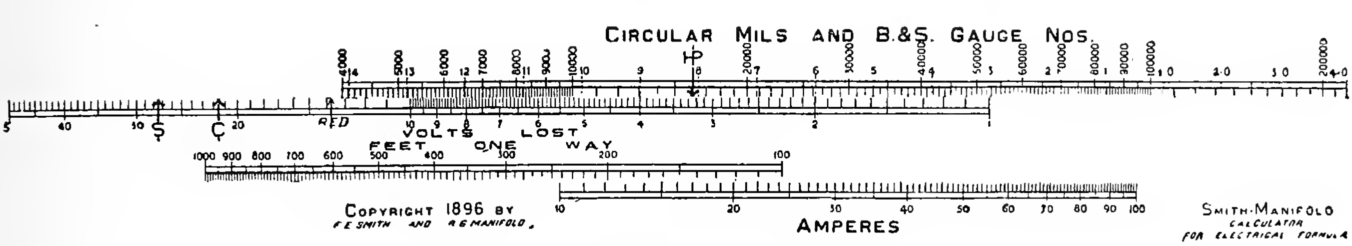

FIGURE 4.—THE SMITH-MANIFOLD CALCULATOR.

(To be continued.)

ELECTRICAL ACTIVITY IN JAPAN.

American electrical engineers may find it not unprofitable to keep a close eye on electrical developments in Japan. During the last session of the Japanese Imperial Diet it was agreed to apropriate a sum of above 12,800,000 yen, or more than $14,000,000, spread over seven years, for the extension of the telephone

service, and the work of construction is being actively carried on at various important places. The number of new subscribers in the four centers of Tokio, Yokohoma and Kobe, under the expanded system, will be over 13,000, and in Kyoto and thirty-five other places where the service is to be newly established, there will be 6800. A considerable number of branch lines will also be established in places of less importance, so that of communication, and it is stated that at present in large part of the population of Japan. The people everywhere are eager to take advantage of this means of comunication, and it is stated that at present in Tokio alone, there are over 2,090 subscribers and more than 2600 applicants are waiting impatiently to have the privilege extended to them also. Arrangements are being made in Tokio to grant 500 new applications during the present year in order of priority, and during the next two years 1500 new applications will be accepted, the intention being to increase the number of subscribers until it reaches 10,000. Notwithstanding the activity of the Japanese in these matters, many of the applications which are being granted this year were sent in so far back as 1893. The ways being made much easier for American manufacturers by the marked preference which the Japanese have shown for American methods. This is strikingly instanced in the fact that three electrical experts, messrs. Mine, Nakayami and Wadachi, engineers of the Department of Communication of His Imperial Majesty, the Emperor of Japan, have lately been sent from Japan to this country for the purpose of studying the latest developments. One of these commissioners says: "All over our empire now there is the greatest interest in electric power and lighting. Electricty has been introduced in several cities, but the goverment wants it all over the country. Beyond a throughly comprehensive telephone system, we want to generate eletricity from the many powerful waterfalls in our country, and to use it for electric railways, general power and lighting, and in connection with our numerous public and private enterprises. It is also our desire to utilize the long-distance telephone in Japan." That Japan is open to adopt the best electrical appliances of any country is seen in a recent large purchase of camp telegraph apparatus in Berlin for service in Japanese military operations, and it is stated that in future the Berlin material will be imported for the use of the Japanes army. It is to be hoped that those persons in this country who are specially interested in the matter, will take careful note of these facts.

ELECTRIC INDUSTRY IN THE UNITED STATES.

In the electric lighting field, the total capital invested in the United States is given as over five hundred millions of dollars. The number of plants, public and private is over ten thousand. The number of motors in use is estimated at about five hundred thousand, and their value at about one hundred millions.

The value of electrical apparatus used in mining is estimated at one hundred millions, and the value of the electric elevator industry will probably not fall short of fifteen millions.

The most important of all the electrical industries, however, is that of electric railways. In this field the investment is very great, and in the United States is represented by a capitalization of over seven hundred millions. The number of trolley cars in use is said to be over twenty-five thousand, and these run on over twelve thousand miles of track. The electric railways represent more than 90 per cent of all the street and suburban railroads of the country.

The aggregate of all the capital invested in electric lighting, electric railways and electric power is about fifteen hundred millions, and this does not include the value of the establishments that manufacture the machinery and apparatus. As many of these are among the largest industrial enterprises in the world, and as nearly all are concerns of considerable magnitude, it is very evident that their combined capital will run up into large figures.

Inasmuch as the electric light and power industry represents an investment of about fifteen hundred millions, without counting the value of the concerns that manufacture the machinery and supplies, it is evident that to estimate the total investment in every department of the electrical industry at two thousand millions of dollars in the United Staes alone, is not extravagant, for this would allow only five hundred millions to cover the value of the telegraph, the telephone and the almost unlimited number of electrical manufactories, large and small, that can be found, from one end of the land to the other.—William Baxter, Jr., in Cassier's Magazine.

DON'T TAKE THINGS FOR GRANTED.

An inventor is about the last person in the world who can afford to take things for granted. A singular case of futility of invention arising from the neglect of this truism has been brought to light by the recording of a recent patent for removing tin from scrap by electricity. As sheet tin sells from 3 to 5 per cent. of pure tin, if all the scrap could be collected and have its tin taken of, an economical process for the purpose would be valuable. Tin is a very expensive metal, worth, say, $400 a ton. If scrap tin is worth $5 a ton $500 worth would contain $1200 worth of tin, and the iron or steel would be worth considerably over $500. The presence of tin makes scrap tin useless as iron, but if it is completely removed the scrap can be worked up into good quality iron. The consequence is that the skinning of scrap iron has exercised a great fascination for inventors for years, and numerous means have been devised for stripping tin, but at last a ingenious electrical device has been patented by which the tin can be stripped off perfectly and deposited where it is wanted. But now that everything is

ready for effective work, it is found that there is practically no scrap tin to be had, and the inventor has had all his trouble and expense for nothing. There were supposed to be thousands of tons of scrap tin wasted every year, but in reality the makers of large tin goods sell their clippings to people who do smaller work, and finally the scrap is distributed in such a way that it cannot be collected profitably.

LAW POINTS FOR INVENTORS.

A patent should be construed in liberal spirit to sustain the just claims of the inventor.

A recovery of damages for the period of infringment does not vest the infringed with the right to continue the use.

A recorded assignment of a perfected invention, made before a patent has issued, carries with it the patent when issued.

However brilliant the discovery of a new principle may be, to make it useful it must be applied to some practical purpose.

An inventor has no right of property in his invention upon which he can maintain a suit, unless or until he obtains a patent for it.

The rightful owner of a patented machine may continue to use it until worn out, or he may repair it, or improve upon it, as he pleases.

If a patented process cannot be performed without danger to the operator, it cannot be regarded as useful within the meaning of the patent law.

The law will strip a corporation or individual of every disguise, and enforce a responsibility according to the very right, in despite of all artifices.

A party who has purchased a patented machine, and used it during the term of the original patent, may continue its use in case patent is extended or reissued

One void claim does not vitiate the entire patent, if made by mistake or inadvertence, and without any willful default or intent to defraud or deceive the public.

An inventor must be understood to know of what his invention consists, and his patent does not secure to him the exclusive right in anything more than he claims.

What is the thing patented, is a question of law for the Court. Has it been constructed, used or sold by the defendants, is a question of fact to be submitted to the jury.

Where a patent is claimed for the discovery of a new substance by means of chemical combinations, it should state the component parts of the new manufacture claimed with clearness and decision, and not leave the person attempting to use the discovery to find it out by "experiment."

An assignment of an interest in an invention secured by letters patent is a contract, and, like all other contracts, is to be construed so as to carry out the intention of the parties to it.

There is no infringement of a patent which claims mechanical powers in combination, unless all the parts have been substantially used. The use of a part less than the whole is no infringment.

In cases of extreme necessity, in time of war and imminent and impending public danger, the Government may appropriate an invention to its own use without the consent of the patentee, but it must compensate him.

A patent may be valid, and may have been held so to be by a court, without being broad enough to cover the whole invention. In such cases the act of Congress tenders the patentee relief by reissuing to make his claim broader.

An inventor who has made an improvement in a machine, cannot include all previous inventions and have a claim to the whole art, discovery or machine which he has improved.

He is the first inventor, and entitled to a patent for his invention, who first perfected and adapted the same to use, and until the invention is so perfected and adapted to use it is not patentable.

Whosoever first perfects a machine is entitled to the patent, and is the real inventor, although others may have previously had the idea, and made some experiments towards putting it in practice.

Where an inventor finds it profitable to exercise his monopoly by selling licenses to make or use his improvement, he has himself, by the price of such license, fixed the average of his actual damage where his invention has been used without his license.

If suggestions communicated by the employee constituted the whole subject of the improvement, the patent, if granted to the employer as his invention, is invalid, because the real invention or discovery belongs to the person who made the suggestions.

The time when a particular apparatus was "constructed," in the sense of the stipulation, was the time when it was attached to the machine (substantially complete in its operative parts), it not being necessary that the machine should be geared and doing work.

Patentees have secured to them, by virtue of the letters patent granted to them, the full and exclusive right and liberty, for a prescribed term, "of making and using, and vending to others to be used," their respective inventions or discoveries; and whenever their rights, as thus defined, are invaded by others, they are entitled to an action on the case to recover actual damages as compensation for the injury.—New Ideas.

THE JOURNAL OF ELECTRICITY.

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VOLUME III. DECEMBER, 1896. NUMBER 6

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EDITORIAL.

TO READER AND PATRON.

The necessity that this paper should be prompt in its issue at the earliest moment, and the greater satisfaction that will ensue therefrom to both reader and patron, have made it advisable that as the present volume closes with this issue, the ensuing one should bear the month of April on its date line. This, then, outlines the course that will be pursued.

The appearance of three belated numbers completing Volume III, with as many weeks, has been accepted as an earnest that the publication of the Journal is to be resumed, and the assurance is conveyed that hereafter this paper will be strictly "up-to-date" in both a literal and a figurative sense.

THE VOICE OF THE INANIMATE.

Whoever it was that gave to mankind the trite adage, "A stitch in time saves nine," was truly a benefactor of the whole human race for reflection convinces that but few of the difficulties which attend our work would arise had we but the forethought to always apply the advice given in this sage precept. Indeed, the painstaking engineer who has worked and won his way to a responsible, paying and satisfactory position may largely attribute his measure of success to the fact that, whether consciously or unconsciously, he has adhered to the broad idea so succinctly expressed in the homely motto. Had the author spent a lifetime in the handling of machinery and had volumes been left replete with ripest experience, there could not have been told a tithe of that expressd in these six small words.

Review if you will the ills to which an electric station is heir, then count on your fingers—you will need no larger score—the difficulties that could have been avoided had a preventive been applied during the incipient stages. It is then, when danger impends, that the voice of the inanimate cries out its warning note and pleads that its needs be administered to. True, if experience be lacking naught may avail to avert a trouble that would otherwise be easily remedied, and if one has not experience he should get it or the path to success will be long and tortuous and without a guiding star. The engine, beast of burden that it is, resents and breaks down under neglect as surely as will your pack horse; the boiler patiently endures the enormous molecular strain thrown upon it by quick steaming or the injection of cold water, but the treatment saps its vitality; the steam pipe when cold, resounds as if struck by a sledge on the sudden admission of steam and the new leaks that appear attest the strain to which it has been subjected; the grain of sand drawn up from the well works an injury to the pump that mechanical amputation alone will save from destruction; the belting, when stretched to fiddle string tightness, spreads its contagion to shafting, pulleys and bearings, and being "one sickly sheep, infests the flock and poisons all the rest;" the heating of a crank pin indicates undue tightness or a clogged oil cup and if the symptom of disorder remains unattended it shrieks in horror at its impending doom; the warming of a loose electrical connection portends derangement that wantonly wastes energy or may open a vital circuit and cause a shut-down or may create the spark that might burn the station or even a whole city; the tiny spark at the brushes preceeds the cutting of the commutator; while an abrasion to armature wires or the lodgement of dust therein results oft-times in a burnout that gives lurid admonition that injury and neglect are not to be tolerated. Thus are given the signs or sounds constituting the language of inanimate appliances. They express no approbation of good and proper treatment beyond being ever ready and willing to cheerfully and reliably perform their alloted tasks, and only at extreme neglect do they raise their voices or mute plaints in infallible warnings of impending dissolution.

Safety, reliability and success in the handling of all forms of machinery demand that attendants shall heed the voice of the inanimate and cultivate an understanding of its expressions. They must cultivate, too, an affection for each piece of apparatus in their charge, for objects of affection are not neglected. If, though, the voice is raised, its grievance is real and then must be instantly applied the stitch that, in electric station practice, saves not nine, but ninety and nine.

DEPRECIATION, AN UNSETTLED FUNCTION.

The measure of depreciation to which electrical machinery is susceptible forms a subject that becomes particularly vexatious on every occasion where upon its estimate hangs actual values in hard dollars and cents. In truth, estimating depreciation is somewhat similar to measuring the candle power of an arc lamp. From the standpoint of accuracy, all favors a correct determination of its candle power when certain known functions are assumed. We can, for instance, fix both the angle and the distance of observation by simple processes, yet these assumptions are purely arbitrary and the results derived will be valueless in fixing the real illuminosity of the lamp owing to the absence of a standard. Similarly, in estimating the depreciation of electrical apparatus, one encounters such potent uncertainties as to render the determination subject to all the errors of personal observation and judgment and a problem which, from the standpoint of accuracy, is impossible of solution.

The depreciation which a dynamo electric machine undergoes is of a dual nature. Its value suffers from a constant shrinkage because of the advances in the art of dynamo building, and second, it suffers from the wear and tear incident to use. To judge either item to even an approximation of certainty is impossible for the respective reasons that no one can foretell when a new invention will render existing aparatus less desirable if not valueless except as junk, and no one can foretell the treatment a generator is to receive, for, as with all other machinery, the life of a generator depends upon the care bestowed upon it. Then again, if a dynamo is kept in good repair, is rewound and rebabitted, and supplied with a new commutator and shaft, it remains to all intents and purposes a new machine and the shrinkage in value from "advances in the art" would really determine the depreciation chargeable to it. The question of efficiency and its impairment from magnetic fatigue would be proper for consideration, but probably few have given the matter a serious thought. Furthermore, it will then be asked: to what extent does the loss of one half of one per cent in efficiency detract from the value of a dynamo? That will depend upon its initial efficiency, the hours of service and the cost of power, each of which is influenced by a score or more of factors that, being more or less ambiguous in themselves, lead to uncertain deductions.

It is plain that experience with one class of apparatus affords no precedent for other varieties. Arc lighting dynamos have been backward in their development and, barring the substitution of new armatures, Brush dynamos installed in 1880 are still being operated and bid fair to continue their usefulness for unnumbered years to come. The depreciation chargeable to these machines would ordinarily be determined by adding to the shrinkage between the original or first cost and the present or new cost, the cost of new parts and repairs, plus an arbitrary amount representing the value assumed to be lost by reason of the use of the machine for the period of its life. In all probability the sum total of these amounts will exceed the present cost of the dynamo, in which event the dynamo is figured out to be not only worthless, but worse than worthless—a zero with even the rim off. Nevertheless it jogs along merrily night after night, putting to blush by its faithful services, its accusers who maintain that if it isn't worthless, in all reason it ought to be.

The reasoning, though apparently sound, is thus proven to be fallacious, in fact, the whole question is an anomalous one and depreciation must remain an unsettled function, for nowhere else must the judgment be so thoroughly tempered by the conditions and circumstances which prevail.

A charge that the original patentee did fraudulently and surreptitiously obtain a patent for that which he knew was invented by another, unaccompanied by the further allegation that the alleged first inventor was at the time using reasonable diligence in adapting and perfecting the invention, is not sufficient to defeat the patent, and constitutes no defense to the charge of infringement.

An inventor may be ignorant of the scientific principle embraced in his invention, or he may think he knows it, and yet be uncertain, or he may be confident as to what it is, and others may think differently. All this is immaterial if by the specifications the thing to be done is so set forth that it can be reproduced.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

TRANSFORMERS FOR SINGLE- AND MULTIPHASE CURRENTS: By Gisbert Kapp, 1896 8vo cloth. 241 pp. Illustrated. Published by The Macmillan Company, 66 Fifth Ave., New York. For sale by William Doxey, 631 Market St., San Francisco. Price $1.75.

It is only comparatively recently that writers of electro-technics have taken up the subject of transformers and treated it with thoroughness in book form. In truth, the reason for this may be because of the almost limitless field that the new science of electrical engineering had opened up for authors to cover, or because of the great amount of experimental research that must be made, or because of a more or less unsettled state of the art; or more probably, because of an immature understanding of the piece of apparatus that is at once the sinew and strength of the alternating and polyphase systems of an electrical distribution. The workings of a transformer appear to be simplicity itself. During its development one realized it to be an appliance wherein a moving field cut a wire and produced electricity, instead of having, as in dynamo, a moving wire cut a field with the same result. With all but the favored few, all thought of the principle of the transformer rested at this point, for as Mr. Kapp states in the preface to the work under review, practical engineers who in carrying on their profession must investigate whatever they design, cannot be expected to publish the result of their researches for the benefit of competitors. The knowledge obtained concerning the theory, principles, and to a great measure, the practical possibilities of the transformer, has until recently been locked in the intellects of the engineers of the great companies, but now the industry has passed beyond the narrow stage where the principles underlying its fundamental features can be reserved for the exclusive use of any person or concern, and as a result the note books of independent but none-the-less trustworthy investigators, have given the electrical public the treasures of knowledge that have long been sought for. Such a work has Bedell's Principles of the Transformer been to students, and such a work is "Kapp's Transformers" to practical engineers and investigators who desire to obtain a maximum of practical success with a minimum expenditure of mental exertion.

Kapp's work clearly shows that notwithstanding the apparent simplicity of the transformer, a study of this apparatus leads to a number of questions which are not only highly interesting from a purely scientific point of view, but are also very important for practical of commercial reasons. On most alternating-current lighting installations the transformers are at work night and day all the year round, and cause a waste of power which is always going on. Under these circumstances, even a small improvement in the efficiency of the apparatus has a large monetary value, but such improvements can only be made as the result of careful study combined with practical experience, and only by grappling with the problem understandingly may its solution be reached. Indeed, the object of the present book is in part to enable the reader to judge the design of the transformers and, if necessary, to design such apparatus for himself. The subject is treated mathematically but not to such an extent as will be oppressive to the majority of readers. Its main features are a scope of discussion that is sought for and a method of treatment that is commendable. All varieties of transformers are fully treated, and though the English and Continental practices are dwelt upon almost to the exclusion of American appliances, yet the names and work of Tesla, Thomson and Scott perforce often appear.

Aside from the explanation given of the principles of action, forms and relations between cores and coils in the transformer, the majority of readers will find more of interest in the pages devoted to testing, in which are satisfactorily described the dynamometer, wattmeter, three-voltmeter, three-ammeter and other methods of testing transformers. Chapter VIII is essentially a practical one, being devoted to safety appliances, sub-station and house transformers, boosters, choke and compensating coils, series transformers, three-wire and balancing transformers, and lastly, a description of Scott's method of converting two-phase to three-phase current and vice versa. Some of the "wrinkles" here brought out are both novel and of value, and it is safe to say, that they would frequently find an extensive application were they more generally understood.

Kapp's Transformers is a timely work, and especially so to the electrical engineer who has charge of an alternating or polyphase current distribution.

THE ACCURACY OF WATTMETER READINGS.

Our readers will recall recent correspondence which passed between Mr. Milne and Mr. C. D. Haskins regarding the merit of the Thomson Recording Wattmeter. We learn that within the past month a series of important tests have been made to determine the accuracy of the meter in question under certain conditions. The tests were carried out to verify sundry criticisms to the effect that on rapidly fluctuating loads, the meter was derelict in its accuracy—especial reference being made to elevator work. The object of the tests was the determination of the mean error under maximum conditions of fluctuation and the result was gratifying from the standpoint of the meter. It was found that the maximum of error, introduced by this character of load, i. e., under the worst possible or maximum condition of fluctuation, did not exceed six-tenths of one per cent, a percentage materially reduced under conditions less than the maximum.

Gas

SOME FACTS RELATING TO GAS AND ELECTRICITY.*

By J. F. Seamon.

With these preliminary remarks, I desire to call your attention to the central station as compared to the gas plant. We must recognize the efficient means which are applied to the different stages of gas manufacture, and while a gas plant's success to a great extent depends upon a correct registration of the product manufactured and sold, and the ample storage of the same, the same principles are applicable to a central station and the distribution of their product, which principles are now being adopted by electrical engineers in the designing of them. It is necessary for the sale of any product to require some suitable means of measurement. As electric power is undoubtedly a product requiring the erection of a costly plant for its production, a unit of measurement is necessary, as well as an apparatus to record the units delivered to the consumer by the producer, and as appliances for recording electric energy, which register in ampere hours (the unit of quanity) and watt hours (the unit of work), are now being generally adopted, it thus makes electricity an equal competitor with gas when such devices are used for the measurement of their product. The writer's experience with the plant in his charge, when electric meters were applied to the consumer, found a reduction in the daylight load of 60 per cent., and the night load of 25 per cent., against that of the contract system. As electric stations receive the benefit of this reduction, and where the revenue by the adoption of meters is not increased, a majority of electric stations have been unable to lessen the cost of their product to the consumer on account of the variable load they are subject to, making it a necessity to have the machinery and dynamo capacity of sufficient size to carry them through the maximum hours of lighting, which covers an average of three hours in twenty-four. As this machinery represents an investment of capital, and, considering the interest, depreciation, insurance and repairs, with no reduction in the cost of attendance, we readily see that in a majority of cases the cost of electricity to consumer is not lessened. The only material reduction would be that of the fuel and water account, which, under the peculiar conditions stated above, amount to a saving of 20 per cent. In view of the facts stated,gascompanies have been able to hold their share of the lighting business, and in many cities they have increased their output by the aid of efficient methods of applying their product as a source of illumination.

Comparing the storage battery with that of a gas holder the electrical engineer, in order to store his energy, must incur a loss of not less than 20 per cent. of the energy stored, and must pay for his storage battery at the rate of $30 per horse-power hour, whether the capacity be large or small, but, on the other hand, the method of storing gas involves no appreciable loss of energy. A 50,000 cubic foot holder, at a cost of $7,000, would be 14 cents per cubic foot capacity, and $3.50 per horse-power hour capacity. Assuming that the consumption of gas is 25 cubic feet per horse-power hour, making a difference of 88 per cent. in the cost of storing an equal amount of energy by the means of a storage battery compared to that of the gas holder. And again, if we desire to compare the cost of installing a storage battery to that of a gas holder of equal capacity, we find that, allowing for leaks and condensation and using the factor of 10 cubic feet per burner per hour, a holder of the size mentioned will furnish gas for one hour to 5,000 burners, at a cost per burner capacity of $1.40. To ascertain the cost of a storage battery of sufficient size to furnish energy to 5,000 16-candle-power lamps at 50 volts, it is necessary to reduce to watt hours, adding 20 per cent. for loss of energy, which equals 300 kilowatts, which reduced to horse-power hours we get a product of 402 horse-power hours,multiplying this by $30, the cost of a storage battery per horse-power hour, we have a total of $12,000 for the cost of the installation of the same of equal capacity to that of a gas holder. It may be stated that storage batteries are confined to the direct current system of electric distribution, and that system is now being superseded by the adoption of the alternating current system in central statons, as the latter, on account of its high potential, covers a greater area in long distance transmission. With the comparisons just stated above, we find this important question of the storage of electric energy a costly one to install, not mentioning the fact of its cost of maintenance, and as the question of capital invested carries with it to a great extent the selling price of any commodity, we can see in this instance its direct application to electric stations, for it necessitates either a means of storage or a sufficient dynamo capacity to carry them through the maximum load.

The gas engine is now being recognized as an important factor for the generation of energy in electric lighting stations, and also in isolated plants, and as it is conceded that it is cheaper to distribute an equal amount of energy by the aid of gas mains than by the method of electrical distribution, and, admitting this to be a fact, it remains for the gas engineer to set forth the practical economy which can be obtained through the agency of the gas engine. The writer calls your attention to one plant in particular at Belfast, Ireland, where gas engines have been installed for the generation of electricity. The gas used was somewhat less than 24 cubic feet per electrical horse-power, the test extending over a duration of six hours at full load. The

*Abstract of a paper read before the thirteenth annual meeting of the Ohio Gas Light Association.

electrical equipment in this instance consists of four bipolar dynamos, of 57½ kilowatts capacity each, and two similar dynamos of 26½ kilowatts capacity each, making a total of 380 electrical horse-power.

In the large cities we find a number of isolated electric plants, and as it is necessary for the electrical engineer in the design of these installations to use a means of producing his energy at a minimum cost, it would suggest that a little enterprise on the part of the gas manager, and with the co-operation of the electrical engineer and the gas engine manufcaturer, the means can be employed to extend the further use of gas as a productive power, thus closely identifying these branches of business, making them dependent to a certain extent upon the other.

In regard to gas as an illuminant as compared to that of electricity, the writer's experience has been, where gas dispelled that of electric light of equal luminosity, a saving of 71½ per cent. was gained in favor of gas, thereby benefitting the consumer. The Welsbach burner was used in this comparison, and the cost of renewing mantles in obtaining the above result is included. With the adoption of the Welsbach burner for gas illumination it certainly was and now is a serious obstacle in the general advancement of electricity for illumination where there is competition. And as the success of the prepayment meter plant is established, a combination of both burner and meter used would enable gas companies to obtain a trade that hitherto was an unknown factor to them. As a manager of a combined gas and electric plant, the writer recognizes whatever is to the consumer's interest, in the method of lighting, is to his interest also, and it only remains for him to give an uninterrupted service and a good quality of light at a minimum cost, using his best judgment in the economical running of his plant, and what additions of extension will be the most profitable to the interests he represents.

Obituary

F. G. PRATT.

We regret to announce the death of F. G. Pratt, of the General Electric Company, which occurred November 7th last. Mr. Pratt was born at Keene, N. H., and graduating from the Grammar and High Schools of that town, entered Harvard. After taking his degree with honors with the class of '84, he returnde to Keene and became sub-principal in the High School in which he had received his early education. This post he filled for three years. He then became identified with the Boston and Albany Railroad in the office of the Electrical Superintendent, but his health failing, he accepted a position with a southern railroad, for which he did considerable surveying work. His experience in railroad operation opened up for him a position in the Union Switch and Signal Company. While with this company he invented and patented several valuable devices.

In 1892 he entered the employ of the General Electric Company and shortly afterward took entire charge of the catalogue department of that company. His special aptitudes and the breadth of his technical knowledge, extending as it did not only into the purely catalogue work, but also over the patent and engineering branches of the electrical business, adapted him peculiarly to the duties which fell to him. Any one acquainted with the vast amount and variety of the printed matter and special information which the operation of such a large company necessitates, and the perfect shape in which is issues from the press will realize the responsibility which rested on Mr. Pratt's shoulders. Mr. Pratt was only 36 years of age at the time of his death. He was universally esteemed and his death will be a source of regret to all who knew him.

Personal

Mr. George Heli Guy, of the staff of the Electrical Engineer of New York, and whose acquaintance is cherished by the hosts of friends he made while visiting the coast some months since, has been enjoying a well earned vacation to his old home in England.

Mr. S. H. Taylor, who is probably more familiar with the electric lighting business of the Pacific Coast than any other person, has succeeded Mr. F. C. Cartwright as Sales Agent for the San Francisco office of the Fort Wayne Electric Corporation, Mr. Cartwright being now associated with the Mutual Electric Light Company.

TAKING CARE OF THE PENNIES.

A scheme for supplying electricity for lighting purposes for small consumers on the principle of the penny-in-the-slot has been in operation in England for some years. Although the conditions of electric lighting there differ greatly in many respects from those in America, there are some points about the enterprise which are worth considering as applicable wherever limited quantities of current are required. The corporation which has the right to the penny-in-the-slot meters, is empowered to enter into contracts with electrical supply companies or municipal corporations for the supply of electric energy; to wire and fit out for electric lighting the premises, such as small stores, etc., of consumers of electricity, and to generally develop and demonstrate the system of supplying electricity through prepayment meters. It is obviously to the advantage of electric supply companies to combine with the syndicate, as the introduction of the penny-in-the-slot system will considerably increase the "earning capacity" of their plant. For instance, while the average revenue from the eight-candle-power lamps at pres-

ent wired in London does not exceed $2.00 per lamp per annum, the lamps used by such consumers as the syndicate propose to introduce, would double or treble the average takings per lamp per annum. By the use of this system the consumer is relieved of the trouble of quarterly accounts. He always knows just where he stands, as one penny will provide an eight-candle-power light for six hours, and the light can be switched on or off at will. This retailing of electric current which is always on tap will be an immense convenience to small stores and private houses, and it promises to mark the era of a new development in the supply of electricity.

The Trade.

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

AN ADVANCE IN WIRE MAKING.

Bi-metallic wire, as its name implies, is composed of two metals, copper and steel being usually employed. Such metals in a wire possesses a peculiar and decidedly beneficial electrical effect, and, at the same time, great tensile strength.

The advantages to be secured from the use of bi-metalic wire may be expressed in a few words, viz., economy in construction, maintenance and operation of conductors used for the transmission of electric currents.

It is especially adapted to telephonic uses, the several reasons being as follows:

1. With the battery transmitter a single bi-metallic wire, with an earth return, accomplishes pracically the same result as is secured from a copper metallic circuit.

2. The magneto telephone, commonly used as a receiver, or an instrument built on the same principle, becomes a commercial long-distance telephone when used in connection with bi-metallic wire in metallic circuit.

3. Bi-metallic wire requires less insulation than wire of one metal, and, as less of the insulating material is needed between conductors of a cable, it follows that a greater number of bi-metallic conductors may be placed and operated therein. This, in turn, increases the capacity of ducts, thus reducing the expense of placing wires underground. With this wire used bare as compared with one metal wire so used, less trimming of trees is required, consequently a saving in the cost of such work is accomplished.

It is not claimed that bi-metallic wire wholly obviates the induction so frequently heard on telephone lines, but it is claimed that when such wire is used the induction does not prevent, nor interfere with, conversation, and that it will give a far more satisfactory service than can be obtained from one-metal wire.

The magento telephone has been found inadequate when used on wires of one metal for any considerable distance, even though such wires were in metallic circuit. The service with that instrument can not be compared to that given with battery transmitters. Bi-metallic wire, however, improves the workings of the magneto telephone to such a degree that that instrument may be considered a commercial long-distance telephone when used in connection therewith.

In the operation of certain systems of rapid telegraphy, especially those systems using both the alternating and direct currents, quick action of apparatus is essential for the successful operation thereof. The peculiar electrical effect in bi-metallic wire produces the quick action needed, and, as a result, an improved service is obtained.

By the substitution of bi-metallic wire for wires of iron or copper, an improved working of telegraphic lines generally will be secured.

Electricity is being generated in vast quantities at Niagara and other points. How to make the power so generated economically available for lighting and manufacturing purposes at neighboring and distant places is a problem of the utmost importance. Likewise is it important to secure a means for the economical transmission of electric currents, whether generated by water or steam power, to any considerable distance. It is believed that bi-metalic wire solves this problem; that, by the use of such wire, the loss of potential, or drop (now of such proportions as to make long-distance transmission over wires of copper almost prohibitive,) will be greatly reduced. From a mechanical point of view, it will be readily seen that bi-metalic wire will render service which is less liable to interruption.

The substitution of bi-metallic wire for copper will prove most advantageous on trolley systems. Copper lacks tensile strength and forms kinks, or bends, from the pressure of the trolley wheel; from this cause arises the possibility of delay due to the flying off of the trolley pole. Besides, copper stretches under its own weight; thus reducing its diameter, increasing its electric resistance, necessitating the frequent taking up of slack, and later on, the breaking of the wire. A taut trolley wire being necessary, frequent repairs are needed to keep the line in working order, and these repairs incur considerable expense. An important item for consideration is that a large sized wire is not necessary to carry the current, except where the trolley wire is also used as a feeder; the great diameter is employed to secure the required tensile strength. This may be termed a waste of copper, because a bi-metalic wire of smaller diameter gives the required conductivity, increased tensile strength and the necessary rigidity.

Iron wire possesses about one-fifth the conductivity of copper wire; to obtain the required conductivity for ordinary uses, an increased diameter is necessary. Iron is not durable as a conductor; on or near the sea coast its life is about three years; inland, about five

years. Then, besides, iron commences to deteriorate shortly after put into service. As the points of oxidation increase, so does the electrical resistance increase, and, although an iron wire may be complete throughout its entire length for a considerable time after put into use, yet its electrical resistance increases more and more as each day passes. As large poles are required, which, owing to the weight carried, must be placed close together, well braced and guyed, added to the short life of iron wire, it will be seen that the economy in an iron wire pole line is only in the first cost of the wire. In the end it will be found that iron is really more costly than copper.

Copper wires of large diameters are frequently employed to secure increased tensile strength, and even then the results sought are not obtained. As mentioned before, copper stretches under its own weight, and unless the slack is taken up at once, innumerable line troubles will appear. Having wires of large diameters to carry, it follows that large poles are required, and, as copper does not permit of great spans, the poles must be placed close together. The tension on the poles is very great, bracing and guying being an absolute necessity, all of which adds to the cost of the line. Copper does not corrode like iron, it is a splendid conductor of electricity, but is lacking in a way which, perhaps, may be considered almost equal in importance to its electrical qualities, viz., mechanical resistance.

Steel possesses great tensile strength, but is a poor conductor; copper is a good conductor, but is lacking in tensile strength.

Bi-metallic wire partakes of the good qualities of both steel and copper—the tensile strength of the former and the conductivity of the latter—and, in addition to the peculiar electrical effect, it is the best and most serviceable conductor. Bi-metallic wire, like copper, does not corrode, and, the steel core, being protected by the copper sheathing, does not oxodize like iron. The two metals of the wire are closely joined, or welded together, forming a homogeneous mass. It permits of bends and twists in the same manner as wire of one metal.

Bi-metallic wire has a greater tensile strength than wire of hard drawn copper. It permits of great spans. Having a greater tensile strength, it will be seen that wire of smaller diameter may be used, which, in turn, permits of lighter poles fixtures, etc., and by reason of great spans, the poles may be placed further apart. Having less surface to wire, poles, etc., there is less resistance to storms of wind, rain and sleet, consequently less liability to interruption of service. The economy is found in every respect.

Old pole lines now carrying wires of copper or iron may have their capacity greatly increased by the substitution of bi-metallic wires therefor. And not only a greater capacity, but an improved service will be secured.

Bi-metallic wire is the product of the John A. Roebling's Sons Company, of Trenton, N. J., which company, as is well known, manufactures only the highest grade of wire.

ELECTRIC POWER IN A BOLT FACTORY.

Although the transmission of power outside the limits of Niagara Falls is not yet a month old, a large nut and bolt works at North Tonawanda, has been waiting, fully equipped for the appearance of the current, for the past year. These works, the largest nut and bolt factory in the country, are those of Messrs. Plumb, Burdict & Bernard.

At the time the electrical equipment was under consideration, the question of utilizing Niagara power naturally arose, and it speaks volumes for the foresight both of the owners of the works and the equiping Co., the General Electric Co., that the three phase system was selected, instead of the two phase. The three phase system having been chosen by the Niagara Falls Power Co., for the transmission of power from Niagara Falls to Tonawonda and Buffalo, the bolt and nut works can be operated directly from the transmission line by simply connecting the necessary static transformers.

The factory of Messrs. Plumb, Burdict and Bernard is situated at North Tonawonda, directly on the lines of the New York Central & Erie Railroads, and about half a mile from the route taken by the over-head wires of the Niagara Buffalo Transmission. It is divided into three single story brick shops, running north and south, the forge being nearest the railroad, the cold shop, engine room and machine shop, lying in the center and the threading and finishing shops on the side nearest the transmission line. All the work, with the exception of the cold work, starts at the forge shop and passes on through the various operations until it leaves the finishing ready for the market. There is no waste of labor and time passing material from the different points in the shops. The progress is methodical, each succeeding operation being set next to the previous one.

Until Niagara power can be obtained, the works are being operated from their own generating station, which will be abandoned as soon as the Niagara Power Company is ready to tap the three phase lines into the factory. The generating station is set between the cold and machine shops in the central building. Steam from the engine is supplied by three Riter Brothers return tubular boilers each of 100 h. p. capacity. The engine is an improved Green of 400 h. p. belted to a General Electric Co. three phase six pole 150 k.w., 25 cycle 500 R. P. M. generator. The exciter is a 3 kw. 125 volt bipolar machine. The switchboard is of panel type, built up of two panels, one for the generator, the other for the feeders. The generator panel carrier Potential Indicator, two current indicators, field switch, main switch and two Carpenter enamel rheostats. The feeder board in addition to the fuses is equipped

with four three-blade knife switches each controlling one circuit and labelled "Cold Press", "Machine Shop", "Thread Shop", "Forge Shop", respectively.

The Forge Shop, where the nuts and bolts are cut off from the raw rods and bars is about 360 feet long, having the forges and machines set down each side of a central aisle, along which a track is laid. Above the machines on each side runs a line of shafting, and in arranging the line of shafting Messrs. Plumb, Burdict and Bernard have adopted a very simple method. Suspended from the roof girders down each side are four lines of channel iron in two sets, each set bolted back to back. Each line is separated from the other about 20 inches. Through the space between each pair of channels, pass long belts which support the hangers for the shafting, and allow of a ready rearrangement at any time. This method is adopted throughout the shop.

The Forge Shop contains five 20 h. p. General Electric Induction Motors, four driving the shafting and one operating a blower. The shafting is divided into four sections, and each one is belted to one of the induction motors.

The driving motors themselves are set upon a platform above the shafting in the center of the shop, and are boxed in. The blower motor directly connected to the blower occupies a platform at the south end of the shop. The machinery driven by themotors in the Forge Shop are different sizes of bolt headers and nut punchers and shearing machines for shearing the bolt lengths from the rod.

In the cold shop the pointing department is operated by one 20 h. p. motor, set on the floor and belted to Jack shafts and counter-shafts as necessary.

In the Machine Shop, lying on the south side of the engine room, is another 20 h. p. motor, also set upon the floor. It is used to drive a variety of tool making machinery such as planers, milling machines drills, slotters, shapers, etc.

The Threading and Finishing Shop, 400 feet long, is next in length to old Shop which is 430 feet in length. In it the bolts and nutstravelling from the other shops are threaded and tapped and put together ready for the market.

This threading and tapping of the smaller pieces is effected automatically for some and semi automatically for others and in all cases the operations involve some of the prettiest automatic and semi-automatic work to delight the eye of the mechanic. The automatic nutters which put the nuts upon the bolts are more than human in their accuracy and speed.

This shop is driven by six 6 h. p. motors set on small platforms, and three 20 h. p, motors. The smaller motors and one 20 h. p. motor is used to drive the automatic and semi-automatic machines. For the former they are belted to Jack shafts from which belts are dropped to pulleys on a shaft running underneath the machinery. For the semi-automatic machinery, the pulley is on the level of the machines and is belted to the Jack shaft above.

The other 20 h. p. motors are set on the floor and are belted to shafting on the opposite sides of the shop as shown in the illustration. These serve to drive the heavy threading and tapping work not automatic and some idea of the variety of machinery in these shops, and the work the motors are called upon to do, may be gathered from the fact that the sizes of bolts made run from 3-16 inch up to 1 1-2 inch.

The advantages of electric drive are markedly noticeable in this plant. There are no separate engines for the individual shops and no belt holes in the walls as would have been the case had the steam driving plant been confined to an outside building. The wires come through three small porcelain bushed holes in the wall of each shop. The central steam and generating station is confined to one room at present, and will probobly shortly be entirely abolished. The motors in the forge shop occupy either small space upon the floor or are erected on small platforms. They require no attention beyond the filling of oil wells, which is performed but once in six months. They are started by the throwing of a switch, and maintain a steady and constant speed under all conditions of load. This is noticeable in the quality of the output.

THE DANGERS OF A SCRATCH.

Scarcely a day passes that many persons do not, in some way or other, get a scratch, a small cut, or a bruise that may break the skin. In most instances not the slightest attention is paid to this beyond the temporary annoyance of the pain and the possible irritation when the hands are put into water, or some subsequent blow in the same spot brings an exclamation on account of the hurt.

This, while a common practice, is by no means a wise one. The air is full of floating disease germs, especially the air of cities and towns, and an injury of this sort, be it ever so slight, might furnish excellent breeding ground for some deadly bacteria. It is a good plan always to keep a bottle of prepared carbolic acid and glycerine, and frequently touch all bruises or sore spots with it. This is one of the most convenient and effective germicides imaginable. It is believed that many cases of fever and other serious ailments can be contracted by a floating germ coming in contact with the abraded skin. Once snugly lodged in this most congenial dwelling-place, the germ multiplies with amazing rapidity, and soon overruns the entire system. Therefore, whenever there is a bruise or scratch, or any injury of this sort, germicidal applications should be at once resorted to.

Where objection was taken to a patent that was signed by "an acting Commissioner of Patents," and that the record contained no averment or proof of his title to the office, held that objection was not tenable.

A POINT IN CENTRAL STATION ECONOMICS.

To what extent a labor-saving device can be made to effect an economy has been very strikingly demonstrated in the case of one of the large electric illuminating companies which recently concluded to fit up each one of its arc light poles with a clock-switching device designed to automatically throw into and out of circuit each of the lights at certain hours of the evening and morning, and thus to supplant the service of the men hitherto employed to make the rounds of the poles and do the same thing by hand. The company had at the time 600 arc lights in use for street illumination. The lights were 400 feet apart, and the city contract specified that they all had to be turned on not later than fifteen minutes beyond a certain hour of the evening, and might be again be turned off not earlier than fifteen minutes before a certain other hour in the morning. Experience has shown that a man could walk about 4,000 feet in a fifteen-minute interval, and turn on or off the ten lights within that distance, so that, for the whole 600 lights, the services of sixty men were required, which could not be secured for less than $4 per week per man, entailing thus the expenditure of $240 per week, or $12,480 per year. The clock-switching devices, which did the same work, cost $5.50 apiece, making a total for the 600 poles of only $3,300, which investment, of course, will not be a yearly recurring one. What the saving effected by the automatic switches will be, may be left to the reader's own calculation. The whole affords a lesson in central station economics in which station superintendents ought to find something decidedly interesting.—From Cassier's Magazine

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Mere change of form is not patentable invention; but to change the form of an existing machine, and by means of such change to introduce a new mode of operation, and thus attain a new and useful result, is the subject of a patent; and it is the new mode of operation which gives it the character of an invention.

When a patentee describes a machine, and then claims it as described, he claims not only the precise forms he has described, but all other forms which embody his invention, and it is an infringement to copy the principle or mode of operation described.

It has been repeatedly held, both by the Supreme Court and in the several circuits, that "the mistake of claiming too little in the original patent has an equal claim to correction with that of claiming too much."

A clause in a contract which finally interdicts the manufacture of a portion of a patented article which may be needed in the repair of such article, is an undue restraint on trade, and will not be enforced.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Elec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

The Journal of Electricity

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GEO. P. LOW

EDITOR AND PROPRIETOR

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The Journal of Electricity

Vol. IV. APRIL, 1897. No. 1

Some Details of the Fresno Plant.

By C. E. DUTCHER.

Much has been published concerning the long distance electrical transmission plant of the San Joaquin Electric Company at Fresno, Cal., and none of the descriptions yet issued equal in any regard that appearing in the Journal of Electricity for April, 1896. There yet remains to be told, however, the technical details of the electrical operation of the plant, and this is the purpose of the present article.

Briefly described, the equipment is of the apparatus of the General Electric Company throughout. At the power house are three 350 kilowatt 700 volt, 60 cycle, three-phase generators, each driven at a speed of 600 revolutions per minute, by separate five-foot Pelton wheels running under a head of 1410 feet. This gives a pressure of 609 pounds per square inch at the nozzle which is the highest pressure at which any electrical transmission in the plant in the world is operated. The wheels are governed by Replogle governors which confine the variations in speed to within two per cent from that at normal operation. The power house also contains two 12½ kilowatt 125 volt, multipolar exciters, each driven at a speed of 1278 revolutions per minute, by separate Pelton wheels operating at a constant pressure of 200 pounds per square inch. These wheels are supplied by a separate pipe line which takes water from a small auxiliary reservoir that in turn is supplied by the main pipe line at a point about one-third of the way up the mountain. The details concerning the remaining portions of the plant will appear hereafter.

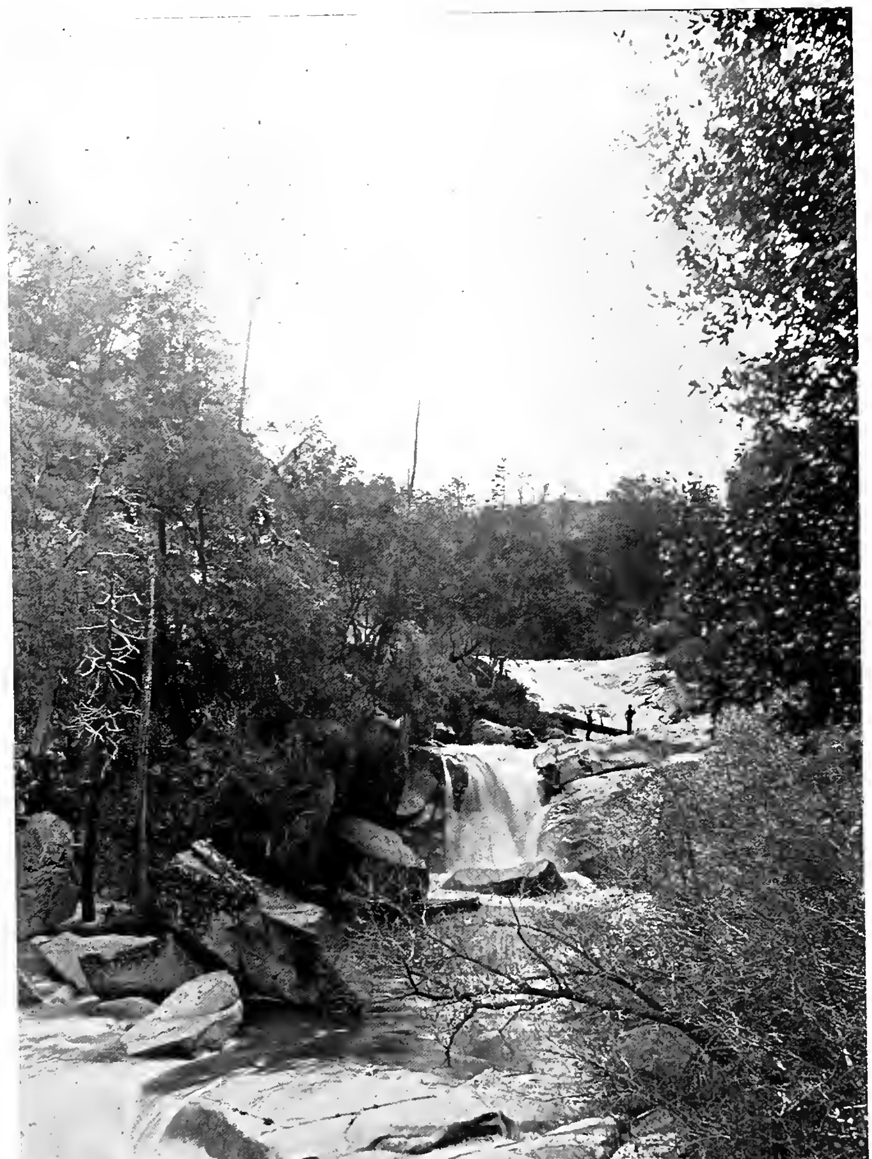


FIGURE 1.—"ELECTRIC FALLS"—DIVERTING POINT OF THE SAN JOAQUIN ELECTRIC COMPANY.

The generally accepted practice in switchboard construction for almost every class of work consists in arranging the appliances thereon so that the instruments shall appear in consecutive order from the top of the board as follows: Lightning arresters, cut-outs, ammeters and voltmeters, main switches, and lastly, the rheostats. The reasons for this procedure are rational ones. Switchboards of modern construction do not give origin to serious trouble in any form. All troubles that occur arise outside of and beyond the switchboard and of these troubles the most serious is lightning, hence the lightning arrester is placed at the point of entry of the line wires to the switchboard. Grounds, swinging crosses and "dead shorts," form the chief remaining sources of trouble and protection against them is had in the cut-out, hence that appliance is almost invariably introduced into the circuit after it has passed in through the lightning arrester, thus affording protection to the switchboard appliances from overload. Next follow the ammeter and voltmeter, located at points most readily meeting the eye; beneath them and placed where most convenient for instantaneous handling are the main switches while at the bottom of the board are the field rheostats, as conveniently placed for ready handling as is possible, but less so than the main switches, because of the two the latter demands more prompt and decisive manipulation. In addition, behind the board are generally placed a cut-out in each dynamo lead before it enters the bus bars. There is a motive actuating both the existence and location of all devices on a modern switchboard for there exists the nerve center of the whole system.

The switchboard at the power house of the San Joaquin Electric Company is built after this plan with the one exception that cut-outs are not introduced into the line. The scheme of operation will be understood by reference to the accompanying cuts in which Figure 2 illustrates the face of the power house switchboard and on Diagram 1 are shown the circuit connections as exist on the back of the board.

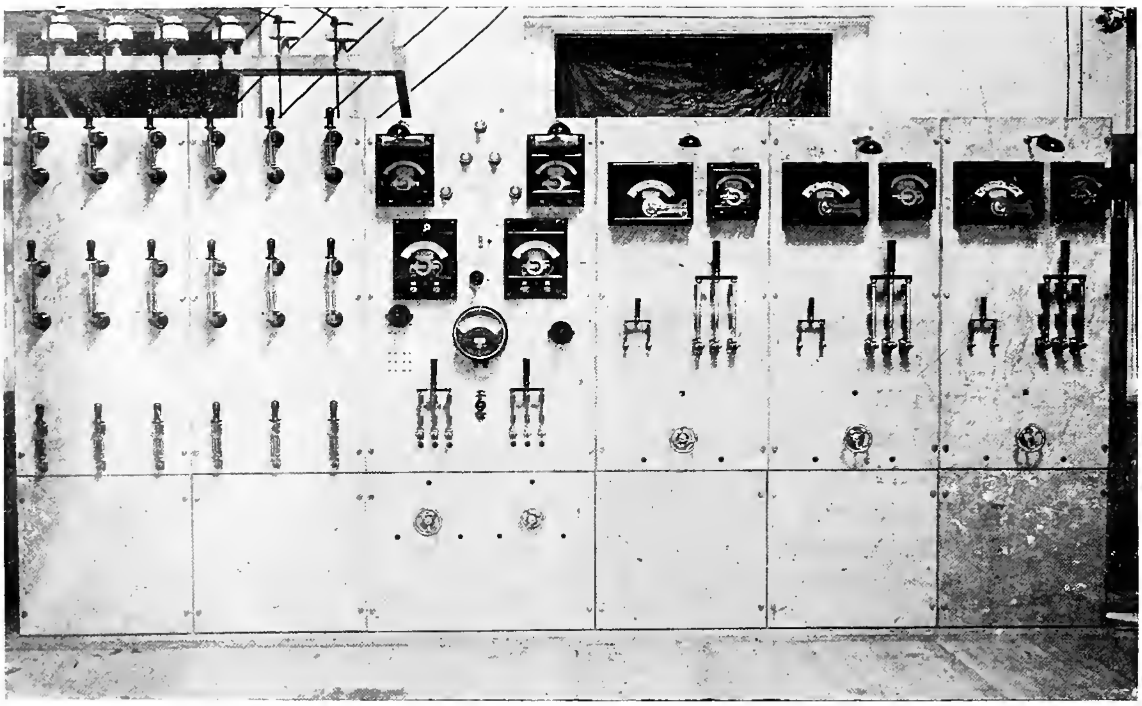


FIGURE 2.—GENERATOR, TRANSFORMER AND LINE SWITCHBOARD AT THE POWER HOUSE OF THE SAN JOAQUIN ELECTRIC CO.

At the outset it should be stated that appliances at the power house are designated by letters or figures which are read as they appear from left to right while at the sub-station in Fresno the reverse occurs and the reading is from right to left. The generators, transformer banks and line circuits are designated numerically, and the leads of the three-phase circuits are designated by the letters A, B and C, as they appear on the power house switchboard.

Referring again to Figure 2, the six panels constituting the switchboard (beginning the numbering from the left) are as follows: Transformer Bank and Line Number 1; Transformer Bank and Line No. 2; Exciters and Generators numbered 1, 2, and 3 respectively. The three horizontal rows of switches on the transformer and line panels are for the control of (1) the lines, (2) the high potential bus bars and (3) the primaries of the step-up transformers respectively. On each of these two panels the three vertical rows of switches control leads A, B and C of their respective devices, hence with all switches thrown in as shown in the illustration the primaries of both banks of step-up transformers are taking current from the generator bus bars, while the secondaries of both banks are delivering a potential of 11,200 volts to the high tension bus bars through the second row of horizontal switches, whence current is supplied to the three legs of both line circuits. This simple switch arrangement enables the cutting out of

either bank of transformers during light load and the utilization of either or both of the transmission lines as desired.

The third, or exciter panel, is a compound one in that it carries the switchboard appliances for both exciters and the other devices peculiar to the operation of a three-phase plant. The exciters are provided with a Weston voltmeter and switch for throwing the voltmeter on to either exciter. Four potential indicators also appeal in this panel immediately below the ground detector and each set of two potential indicators has an independent transformer by means of which the generator and bus bar potentials are indicated as are also the generator and bus bar pilot lamps and the synchronizing lamps. At the sides of the Weston voltmeter are four sets of plug switches with two, four-legged plugs by means of which the potential of either generator and of the bus bars may be determined as is necessary in synchronizing generators. The upper right hand switch is used solely to give the bus bar potential and the remaining three switches, which appear on the switchboard as merely twelve holes in a group, are for generators 1, 2 and 3 respectively as shown in Diagram 2.

These plug switches are simple, yet ingenious devices. In three-phase work it is not essential to know the voltage of each circuit at all times, but it is necessary to learn the potential of the circuits at irregular intervals or whenever the load on any side varies.

The use of but a single voltmeter and voltmeter transformer, therefore, suffices for determining the voltage of all the generators, but as each generator has three circuits, there are consequently nine circuits into which the voltmeter must be cut and the plug switch referred to has been adopted as the most simple and ready means for doing this work without affording the slightest possibility for short-circuiting. Reference to the diagram will show the circuit connections of the plug switches which are shown to consist of two simple bars having three holes in each and forming the voltmeter terminals, besides two shorter bars, each having two holes and placed outside the voltmeter bars. These short bars are staggered so that the first one spans the two upper horizontal rows of holes of the switch, while the lower one spans the two lower horizontal rows of holes. The short bar in the upper left hand corner is connected to leg C of a given generator; the short bar in the lower right hand corner is connected to leg B of the same generator, while the remaining leg A is presented in the diagonally opposite holes of the remaining corners. The four-legged plug shown in Figure 2 consists of a bar of ebonite with a circular hand shield and from which project four metal pins, numbers 1 and 2 of which are short circuited together, as are also pins numbers 3 and 4. In Figure 2 the plug is shown inserted in the upper row of holes of the potential switch for generator No. 1, (see diagram No. 1) hence the reading on the generator voltmeter gives the reading of

FIGURE 3.—RESERVOIR OF THE SAN JOAQUIN ELECTRIC COMPANY.

circuit A C of that dynamo. Similarly the four-legged plug switch at the right of the Weston voltmeter gives on the bus bar voltmeter the potential of bus bar circuit A B.

On the face of the switchboard are four potential indicators, but for simplicity only two of them are shown in Diagram 1. Of these four, two voltmeters are placed in parallel across each switchboard transformer, and the entire group forms a series-multiple with the lamp circuits. The readings of the two voltmeters on the same transformers are, therefore, alike, but it is found that their presence facilitates quickness in observation and switching. The voltmeter transformers reduce the potential from 700 volts to 100 volts.

grounded side is cut out, causing the remaining lamp to take full voltage.

In the three-phase ground detector, a single lamp as shown at the apex of the triangle of lamps on the face of the switchboard, is used, but is in series with a choke coil as shown in the diagram, for cutting down the potential applied to the lamp from 700 volts to 100 volts. Immediately above the Weston voltmeter is the ground detector switch, consisting of four holes, three of which form the points of an equilateral triangle and the fourth one is centered therein as appears in the drawing. A two-legged plug is used, which bridges between the center hole and either of the three outside ones. The center hole leads to earth through the choke coil and lamp, while the remaining

FIGURE 4.—ELECTRIC PUMPING STATION AND RESERVOIR OF THE FRESNO WATER COMPANY.

The ground detector is an adaptation of the two-lamp detector common in two-wire incandescent installations and in which two 100-volt lamps in series are placed across a 100-volt circuit, the connecting wire between the two lamps being put to ground through a snap or plug switch. Normally, each lamp burns to but one-half candle power, but on throwing on the ground wire of the detector, if either side is partially grounded or is dead grounded, one lamp dims and the other brightens, or the first lamp goes out altogether and the other comes up to full candle power according to the seriousness of the ground, for if a lead is dead grounded, the resistance of the lamp on the

contacts lead to the three generator bus bars respectively. If the plug grounds leg B through the lamp and choke coil as shown in Figure 2, the lamp will burn dim if partially grounded or it will not burn at all if it is on a dead ground, while if the plug grounds the remaining bus bars through the other two holes, the lamp will burn brightly in each case, signifying that the bus bars A C are clear of grounds.

The form of lightning arresters used is described in the article referred to, but it may be stated here that it is of the Wirt type as exclusively used by the General Electric Company in high potential transmission installations. It is not a non-arcing arrester in

the sense in which the term is usually applied, but instead,its action seems to be one of breaking the discharge into numerous small sparks that jump the small air gaps between the metal balls which appear to chill and put out the discharge as effectually as if of non-arcing metal.

The connections of the exciter on the exciter panel follow ordinary practices, hence, as they present no unusual features, they are not detailed. It is clear from the diagram that the exciters feed into a set of exciter bus bars which is continued to the right along the back of the generator panels. From these bus bars current is taken to the fields of each generator through an independent double-pole switch, a field rheostat and an ammeter, the latter being located in the upper right hand corner of each generator panel. The three remaining panels are for the respective generators, each of which feeds into the set of bus bars through 350 ampere fuses and a triple-pole switch. The B lead of each generator feeds into its bus bar through a current indicator shown in the upper left hand corner of each generator panel. It is evident from Diagram 1 that the lower set of bus bars on the transformer panels are but a continuation of the generator bus bars on panels 4, 5 and 6.

With the exception of the location of the ammeters, the switchboard connections of these three-phase generators are practically the same as those for an Edison three-wire system in which as many dynamos are run in parallel as are required to carry the load. This is exactly that which is done with the three-phase generator in the power house of the San Joaquin Electric Company. The generators run singly or in parallel with equal facility, in fact the station attendant who has operated incandescent dynamos or street railway generators in parallel will experience no difficulty in paralleling three-phasers after he has learned how to synchronize them. Like direct current generators, three-phasers when operating in parallel must be up to voltage (in addition to being "in step") before being thrown together, then its portion of the load must be thrown on to the second machine by increasing its voltage and equalizing the speed and if the voltage or speed of the second generator falls below that of the

FIGURE 5.—FRESNO MILL OF THE SPERRY FLOUR COMPANY, IN WHICH ELECTRICALLY TRANSMITTED POWER HAS SUPPLANTED STEAM.

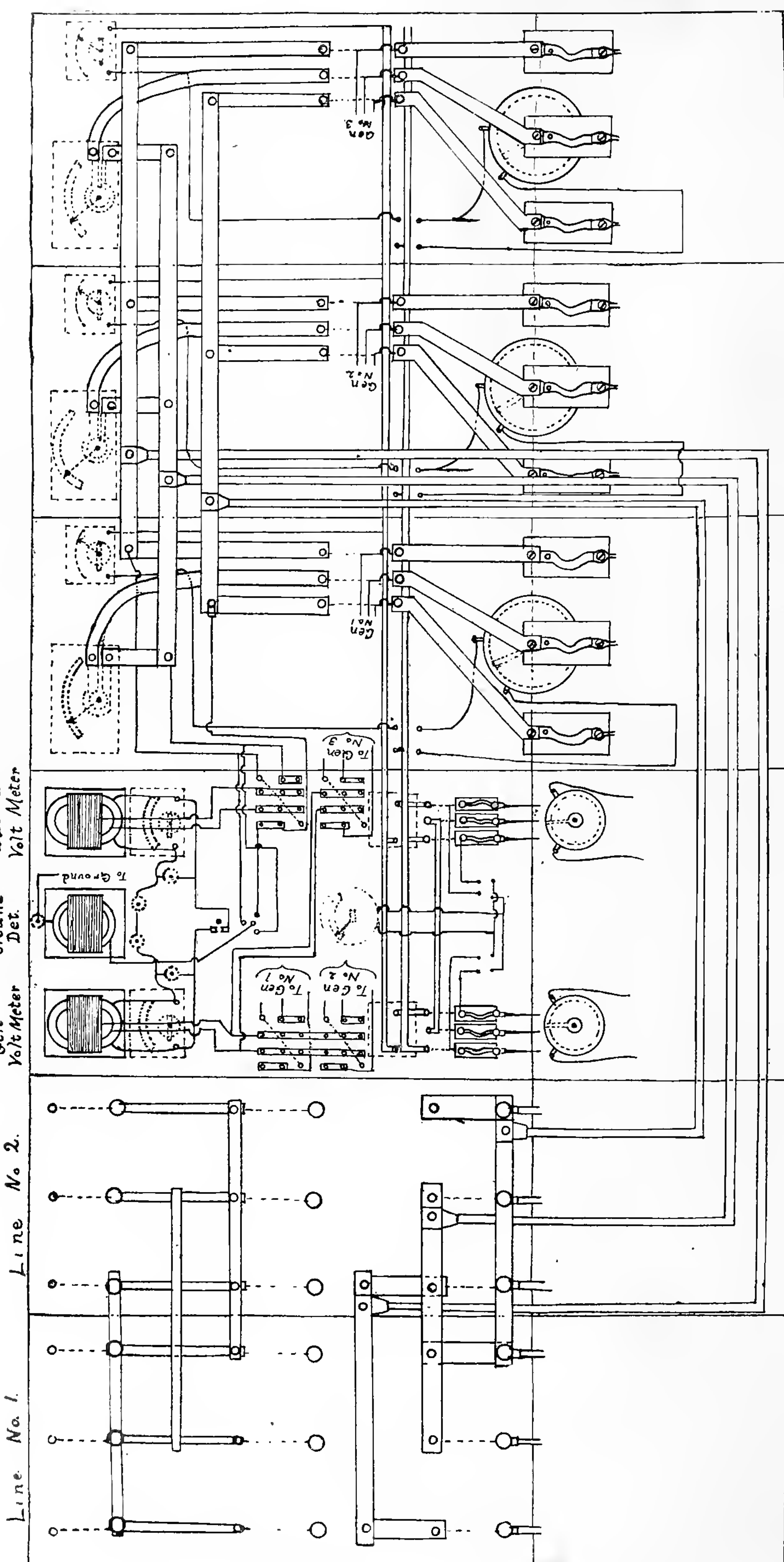


DIAGRAM 2.—DETAILED CIRCUIT CONNECTIONS OF THE GENERATOR, EXCITER, TRANSFORMER AND LINESWITCHBOARD IN THE POWER HOUSE OF THE SAN JOAQUIN ELECTRIC CO., AS ILLUSTRATED ON PAGE 2.

other it will be driven by the latter as a motor throwing additional load onto the first generator or the one having the higher speed and voltage.

Before proceeding to a description of the method of synchronizing it may be well to point out that the plant is never started, nor are the existing conditions altered in any way without consultation by telephone between the power house and the Fresno sub-station. The telephone line is carried on the transmission poles on independent cross arms placed thirty inches below the high potential circuit; it is transposed every mile, yet despite the distance (thirty-five miles) the line is silent and conversation is readily carried on at any time. In starting, the exciter is first brought up to speed, the field circuit of generator No. 2, for instance, is closed and the excitation is adjusted to the proper voltage after the manner of starting up an ordinary single-phase alternator. The generator is then brought up to speed when the main switch on the generator panel is closed, setting the entire plant in operation as the switches on the transformer panels would have been properly set before starting up. If now, the load increases beyond the capacity of generator No. 2 and it becomes necessary to put generator No. 1 in service, the field switch on generator panel No. 1 is closed, (a single exciter has sufficient capacity to operate all three generators) the voltage of one of the three-phase circuits is taken by inserting the four-legged plug in one of the horizontal rows of holes of the upper right hand plug switch which will take the position shown in Figure 2. When the potential of the generator equals that shown on the bus bar voltmeters, the impulses of electro-motive force of each generator must be brought into step or into synchronism with each other. This is done by means of the synchronizing lamps.

On the face of the switchboard appears five incandescent lamps; the upper one is as stated for the ground detector; the middle two are the synchronizing lamps and the lower two are pilot lamps, one for the generator and one for the bus bars. The mode of connecting the lower four lamps is clearly shown in Diagram 1, where the pilot lamps are seen placed across their respective transformers, while the synchronizing lamps are in series with each other and the transformers, but with the circuit interrupted by a plug switch. On closing the lamp circuit by inserting the plug, the two voltmeter transformers work in opposition, in part opposition, or together in burning the synchronizing lamps, according to whether their respective generators are altogether out of phase, or whether they are partly in step, or whether they are synchronous. The lamps, therefore, blink according to the conditions of the phases and when a long wave or blink of the lamp occurs at an instant when the lamps burn at full incandescence, the main switch of generator No. 1 is instantly closed, after which the lamps burn without fluctuation, showing that the generators are synchronizing. The field of generator No. 1 is then increased until it has taken its proper share of the load and the same mode of procedure is followed in putting the remaining generator in service. The three-phasers are cut out of service precisely as would be done with a railway generator.

Of course the banks of step-up transformers, which have both primary and secondary coils wound in delta, are cut on or off from the generator bus bars according to load by the use of two lower arms of single-pole switches on the transformer panels. The lowest row controls the 700 volt primary entering the step-up transformers; the middle row of switches cuts the 11,200 volt secondary (the transformers have a ratio of 16 to 1) on to the high potential bus bars, while the line circuits are fed from these bars through the upper row of single pole switches. The apparatus of the station is in duplicate throughout and is so installed that any part of it may be disconnected from service at will.

The construction of the transmission line has been fully described in the article previously referred to, hence it is sufficient to state that it consists of two three-phase circuits of No. 1 B. & S. bare hard drawn copper wires carried on two eight-foot cross arms supported by 40 foot poles. Legs A and B of each circuit are placed equi-distant on the top cross-arm and leg C of each circuit is placed centrally on the lower arm so that in a sectional view the wires form the points of an inverted equilateral triangle with sides twenty-four inches apart. Triple petticoat porcelain insulators are used throughout.

The manner in which the main line enters the sub-station in Fresno is clearly shown in Diagram 2, and after passing through the lightning arresters and choke coils, the lines terminate at the clips of the upper row of single pole switches on the high potential board. The fulcrum of these switches cut into the high potential bus bars which are a counterpart of those on the high potential board at the power house. Indeed, the same scheme of switching prevails in both instances, but in reverse procedure, viz: the utilization of either line or transformer circuit, single or in parallel with the other as desired. From the high potential bus bars in the sub-station the three-phase current is led through single pole switches to three sets of step-down transformers of the General Electric Company's air blast type. Each of these three banks contain three transformers; those in the first set each have a capacity of 125 kilowatts and reduce the potential from 10,000 volts to 125 volts. The primaries are wound in delta while the secondaries are wound Y with a common neutral, hence it delivers 125 volts between either of leg A, B and C and the neutral wire or 200 volts between legs A, B and C alone. The second and third sets consist of 75 kilowatt and 40 kilowatt transformers respectively; they are wound delta in all parts and take current at the line voltage delivering it at 1000 volts. The entire three sets are placed in operation by the row of single pole switches extending horizontally along the middle of the high potential

switchboard and their secondaries are broken by the single pole switches on the lower rows of their respective panels all as clearly shown in Diagram 2.

The entire incandescent lighting load, as well as the small motor load, is carried by transformer set No. 1 in which, as stated, the secondaries are wound in Y. The neutral wires of these transformers are connected together to a single wire which leads through a single pole switch shown at the bottom of a panel of the low tension distributing board whence it proceeds out of the distribution lines. The remaining legs are cut into the bus bars of the incandescent distributing board extending from panel 2 to 6 inclusive, through current indicators. Seven circuits are taken from these bus bars, five of which are included between panels numbered from 2 to 6 inclusively, are used for incandescent and small motor service as stated, while the remaining panel or panel No. 1, at the extreme right hand end of the board, operates two 60 horse-power 200-volt induction motors which are direct connected to two 80-light Brush arc dynamos. The characteristics of the switchboard will be understood by reference to Diagram 2, from which it will be seen that the current entering the low tension bus bars from Transformer set No. 1, is thrown into the bus bars direct without any intervening device. From the bus bars current is thrown to the various distributions through triple pole switches, whence it proceeds through potential regulators or boosters to line after passing through cut-outs and the ammeters shown at the top of the board. From each of the various distributing centers about the city four pressure wires are run back to the sub-station switchboard as in the Edison three-wire system.

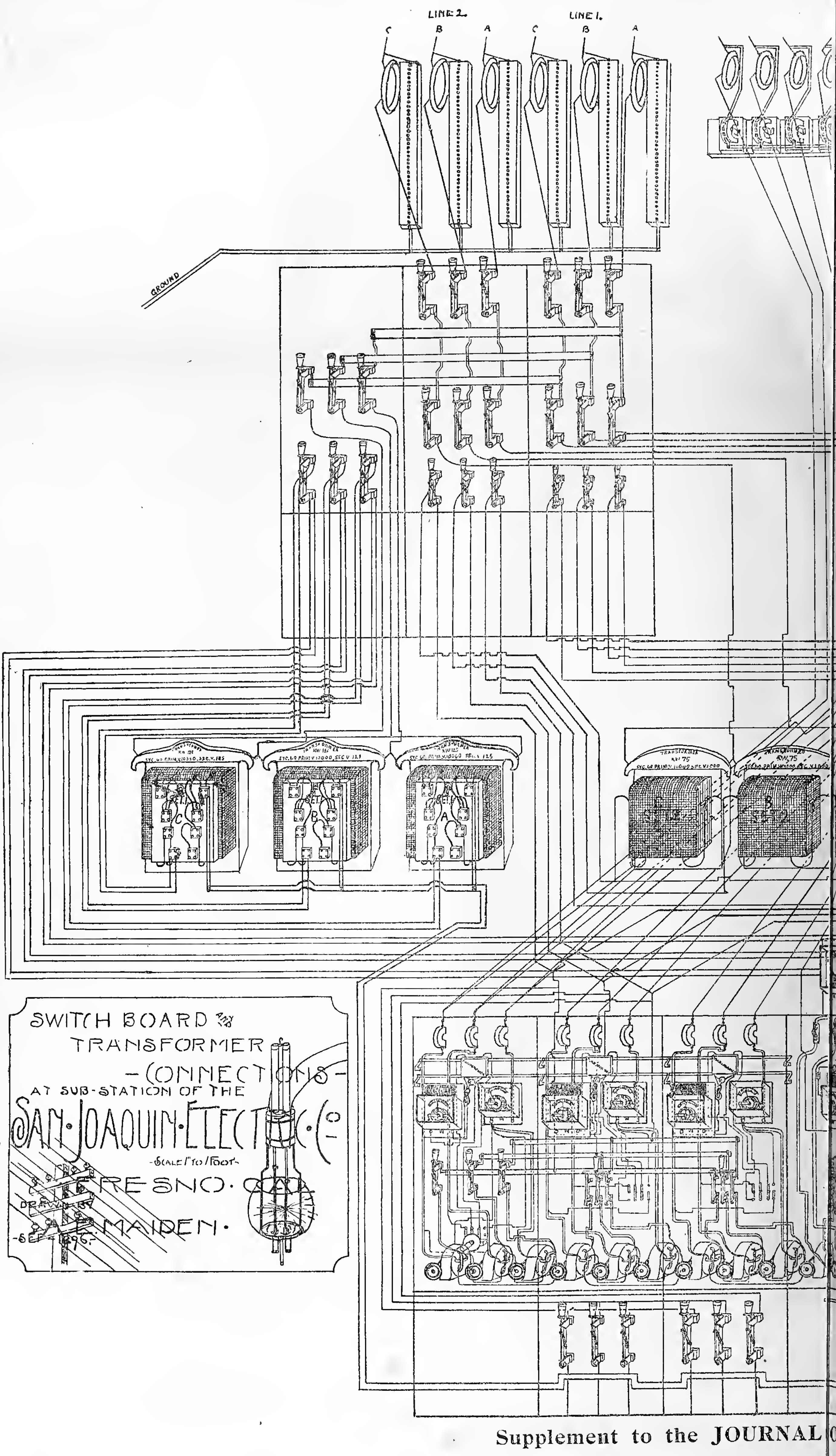
These pressure wires terminate in the three-point switches appearing on the low tension panels and by means of which the voltages of the various legs of the circuit to neutral are shown. The boosters referred to are connected in series with the outgoing leads. These regulators consist of two stationary coils placed at right angles to each other and fitted into four large slots in an exterior stationary magnetic iron circuit. Within the coils is an iron core which may be turned in relation to the stationary field so that by moving the core a portion of a revolution the field set up by the primary coil may be shifted in its direction so that more or less lines of induction will interlink with the secondary coil and thus produce an increase or decrease in the secondary potential.

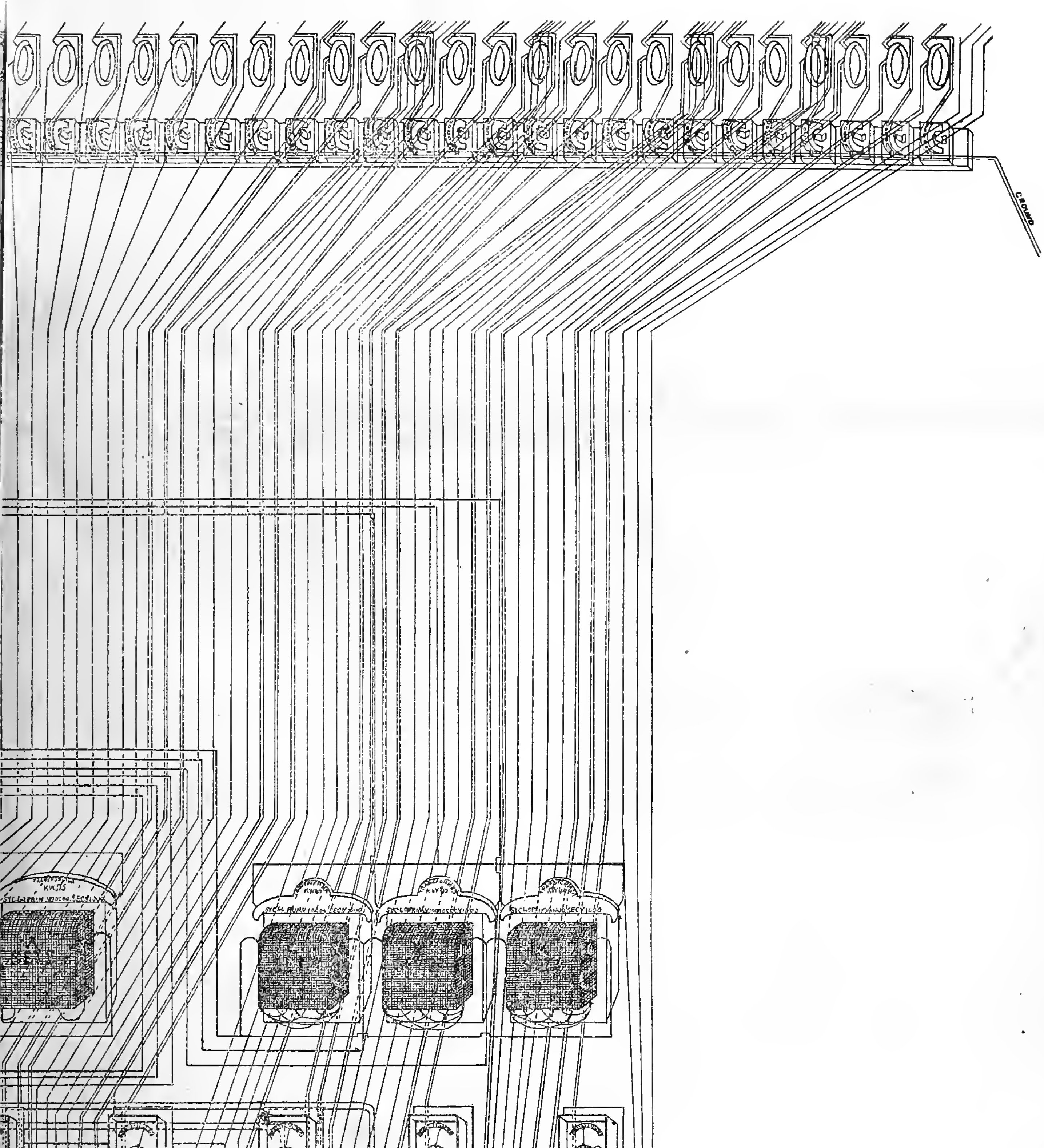
It should be understood that the incandescent and small motor service is operated on a four-wire distribution; that is, three wires for the three legs of the three-phase circuit and one wire for the three-phase neutral. The city distribution circuits have five feeding-in points corresponding to the five panels referred to and should the potential of any distributing center vary to an extent greater than that which can be corrected by the boosters, it is the practice to equalize by breaking the circuit of that leg of the center which shows the highest pressure, in which event the line loss is made to compensate.

As stated, the remaining step-down transformers have secondaries connected in delta and deliver current to the last three panels of the switchboard to the left, in the manner shown in Diagram 2. Transformer sets 2 and 3, therefore, have common bus bars which extend along the length of the three panels last named. Five circuits are taken from these bus bars at a pressure of 1000 volts: Circuit No. 1 is used as a power circuit to operate a 75 horse-power 1000-volt induction motor, driving a rotary pump in the Fresno Water Works, the exterior of which is shown in Figure 4. This pump has a capacity of 3,000,000 gallons daily and has displaced the use of a large steam Holly compound duplex pump having a capacity of 4,000,000 gallons. The second circuit, which is also a power circuit, operates a 180 horse-power 1000-volt synchronous motor for running the Sperry Flour Mill. The third circuit is used as a lighting circuit in the Chinatown district. The current is carried from the sub-station at a pressure of 1000 volts to Chinatown, where, by means of secondary transformers, having their secondaries wound in Y, it is reduced 200 volts and 115 volts for incandescent and small motor service. The fourth and fifth circuits are operated similarly to the Chinatown circuit, but extend to the County Hospital and outlying districts, where they are transformed down to 115 volts for incandescent lighting. The service controlled by panels 6, 7 and 8 is regulated as on the low tension panels, and panels 6 and 7 containing 1000-volt circuits numbered 3, 4 and 5 are provided with four-legged plug switches, which being operated in conjunction with voltmeter transformers, give the potential between either legs of the 1000-volt distribution. As in the previous instance, it is clear from the diagram that this distribution comes from the bus bars, proceeds thence through switches, boosters, ammeters, cut-outs, choke coils and lightning arresters to the local distribution all as clearly shown in detail on Diagram 2.

The Fresno transmission plant is at present operating a load of 5800 incadescent lamps, 25 "Manhattan" alternating arcs, 148 type "M 2," 2000 candle-power, double carbon Thompson-Rice arc lamps and about 525 horse-power in motor service.

The success of the operation of long-distance electrical transmission is perhaps best gauged by the opinion expressed by operatives of the plant, and the writer, who has been an operative of the power house equipment, and who is at present employed in the sub-station, feels fully competent to endorse the statement of Mr. John J. Seymore, President of the San Joaquin Electric Company to the effect that all the machinery has worked with perfect success from the start. The incandescent lights have most of them been newly wired in thus enabling a proper balance of the load and the regulation has given no trouble whatever.


LINE 2.
LINE 1.
C
B
A
C
B
A
GROUND
SWITCH BOARD AND
TRANSFORMER
-CONNECTIONS-
AT SUB-STATION OF THE
SAN·JOAQUIN·ELECT C·C°
-SCALE 1" TO 1 FOOT-
FRESNO·CAL
DRAWN BY
E. MAIDEN·
-SEP-1896-



F ELECTRICITY for April, 1897.

In conclusion, the writer desires to express appreciation of the services of Mr. A. E. Maiden, switchboard attendant at the sub-station, for the care and fidelity with which he has executed the circuit drawing, from which Diagrams 1 and 2 are reproduced, and which are drawn to scale in every detail.

THE SMITH-MANIFOLD CALCULATOR.—IV.

By Geo. P. Low.

The energy of a given circuit is expressed in watts and 746 watts are required to produce one electrical horse-power, while 1000 watts constitute a kilowatt, which is the unit of energy measurements generally accepted in commercial transactions. The electrical energy is derived in the product of the volts and amperes of a circuit and probably the very simplest of the many uses to which the Smith-Manifold Calculator may be put are in the determinations of wattages and electrical horse-powers together with their component functions. When the volts and amperes of a circuit are given and it is desired to know its wattage, the Calculator stands ever ready to save the time that a problem in multiplication would otherwise consume. Moreover, it is absolutely mistake-proof.

Eleventh Example: What is the wattage of a motor taking 31.6 amperes from a 220-volt power circuit,

To solve this and all kindred problems, read amperes direct on the ampere scale; read volts direct on the feet-one-way scale, and read watts direct on the circular mils scale. Adjusting the Calculator after this manner for the factors given, 31.6 amperes is placed opposite the 220-volt mark as in Figure 3, when above the arrow "C" on the circular mils scale is read 6950, the watts required.

Twelfth Example: What current is required to operate a 20 kilowatt 220-volt motor to rated capacity?

Proceed in the manner outlined by placing the arrow "C" opposite 20,000 watts (20 kilowatts), then under 220 volts on the feet-one-way scale is read 90.9 amperes, the current required.

Evidently to continue in the elaboration of so simple a procedure would be redundant, hence without further explanation is given:

Rule 2. To find the wattage of a circuit: Read watts direct on the circular mils scale; read volts direct on the feet-one-way scale and read amperes direct on the ampere scale, then the product of the amounts shown by opposite marks on the feet-one-way and ampere scales gives the watts indicated on the circular mils scale by the arrow "C."

The calculation of electrical horse-power is equally simple and from what has been said it is clear that the ordinary method of deriving the electrical horse-power of a circuit is to divide its wattage by 746. Long division at best is irksome, but it is a positive exasperation when means are at hand for performing its work instantly by a mechanical device such as the Smith-Manifold Calculator.

Thirteenth Example: Required the electrical horse-power of a circuit carrying 40 amperes at 500 volts.

Let the figures on the feet-one-way scale represent volts direct, then place the mark indicating the proper voltage so derived, and which in this example is 500, opposite the stated current or 40 amperes, when the scale appears as in Figure 2. Immediately under the horse-power arrow on the circular mils scale, then appears the required electrical horse-power direct or 26.8 e. h. p. Were the current but 20 amperes at 500 volts, the energy would evidently be but one-half of that amount or 13.4 electrical horse-power which is shown in the Calculator setting appearing in Figure 1. It is also obvious that under Rule 2 the wattage of these two circuits would be 20.000 and 10,000 respectively.

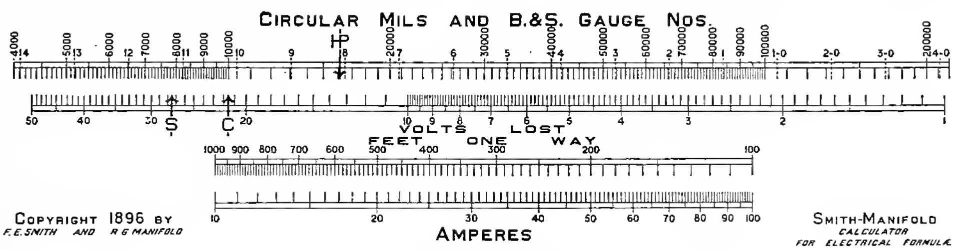


FIGURE 1.—THE SMITH-MANIFOLD CALCULATOR.

Fourteenth Example: After deducting all losses it is found that a constant current motor to be run on an 18 ampere circuit must absorb therefrom 9.35 electrical horse-power. What will be its voltage?

Place the Calculator as in Figure 3 with the horse-power arrow on the 9.35 mark (e. h. p.) on the volts lost scale, then over 18 amperes read 387 volts, the potential required. We have also seen that from Rule 2, the energy consumed by this motor will be 6.95 kilowatts.

Fifteenth Example: A 2200-volt alternator is putting out 11 amperes on the primary circuit. What is the electrical horse-power?

As 2200 does not appear on the feet-one-way scale, it is necessary to drop a cipher therefrom and bear in mind that the result read on the calculator must be multiplied by ten in consequence. Adjust the scale after the manner described in the Twelfth Example,

and it will appear as in Figure 4 with 220 volts over the 11 ampere mark, while under the horse-power arrow appears 3.24 e. h. p. which multiplied by 10 gives 32.4 e. h. p. Should the wattage of this combination be desired, reverse the slide as previously described, that is, draw it to the right until 10 volts on the volts lost scale reaches the point occupied by 1 volt in Figure 4. That is a trifle below the No. 3 wire mark. This action has multiplied the reading above the arrow "C" by 10, hence the direct reading so obtained (35,600) must be the wattage required, because in assuming 220 volts instead of the 2200 volts given, the given quantity was divided by 10, and in sliding the scale to the right the given quantity was multiplied by 10, therefore the wattage is unchanged.

This mode of procedure gives rise to:

Rule 3. To find the electrical horse-power of a circuit: Read volts direct on the feet-one-way scale; read amperes direct on the ampere scale, then the electrical horse-power of the volts and amperes shown by opposite marks on the feet-one-way and ampere scales is indicated on the volts lost scale by the horse-power arrow direct.

As is well known, the area of a wire may be expressed either in circular mils or in square mils, but the practice of using circular mils is so flexible and has become so general as to give it almost universal acceptance. Nevertheless, there are times when it is necessary to know the square milage of a conductor. A mil is one one-thousandth of an inch, hence a conductor one inch square would measure 1000 mils on a side and have an area of 1,000,000 square mils. The circular mileage of a wire is its diameter in mils squared, hence a wire having a diameter of one inch has an area of 1,000,000 circular mils. Obviously, one circular mils equals .7854 square mils and to reduce circular mils to square mils, or vice versa, involves a tedious arithmetical process. It is not so in using the Smith-Manifold Calculator, however, for when the arrow "C" is placed on a given circular milage, over the arrow "S" appears the equivalent square milage.

Sixteenth Example: What is the square milage of a conductor having an area of 6,950 circular mils?

Place the arrow "C" on 6,950 as in Figure 3, then over the arrow "S" read 5460, the square mils required. To find the circular mils when the square mils are given, simply reverse the order of procedure, and from these methods is derived:

Rule 4. To find the area-equivalents of a conductor: The readings on the circular mils scale opposite the "S" and "C" arrows express direct the area-equivalents in square mils and circular mils respectively.

So diversified are the conditions attending the use of electric conductors that it is impossible to define safe carrying capacities that shall be standard for the various sizes of wire. A given size of wire placed in an iron armored conduit and run in a cold storage warehouse will carry a materially greater current than one incased in a wood moulding and run alongside a hot air flue, for in the first case the heat is conducted away by convection; similarly a given size of wire will not carry the same current when wound on an armature as when strung on a pole line, hence, in figuring the safe carrying capacities, the most general practice has been to determine the carrying capacity first at the rate of 2000 amperes per square inch, and second its carrying capacity at the rate of 1000 amperes per square inch. Given the area of a conductor, its carrying capacity at either of the rates given may be readily determined by arithmetical processes, but the Calculator method affords far greater facility as will be shown by the

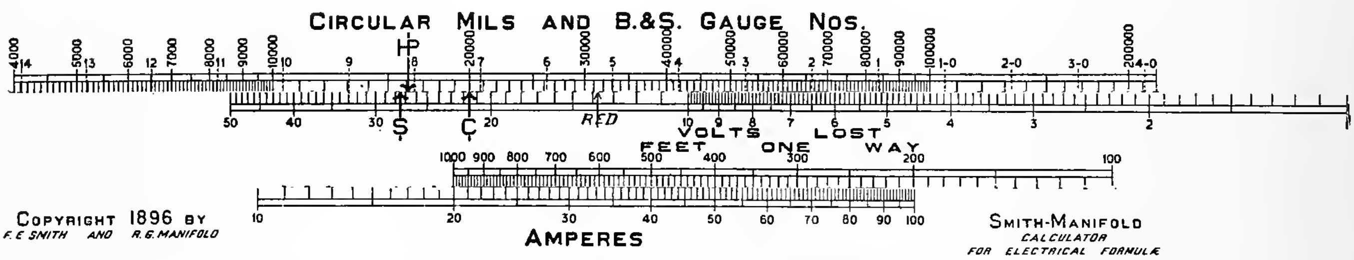


FIGURE 2.—THE SMITH-MANIFOLD CALCULATOR.

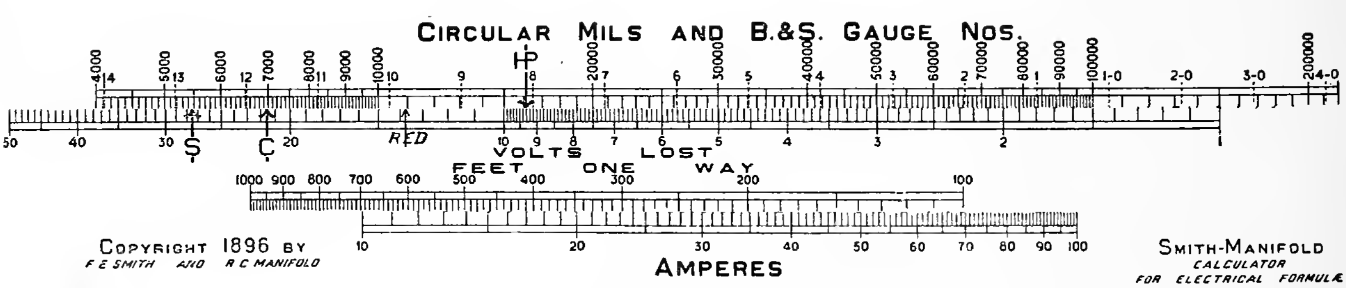


FIGURE 3.—THE SMITH-MANIFOLD CALCULATOR.

Seventeenth Example: What is the carrying capacity of a wire having an area of 20,000 circular mils to be used at the rate of 2000 amperes per square inch.

Place the arrow "C" on 20,000 appearing on the circular mils scale as in Figure 2 and the reading over the red arrow, when divided by 1000, will give the carrying capacity required, which in this instance is 31.5 amperes again.

Eighteenth Example: What size of wire is necessary to carry a current of 10.95 amperes at the rate of 2000 amperes per square inch?

Since in the preceding example it was necessary to divide the reading appearing over the red arrow by 1000 to derive the amperes, it is also necessary in the present instance to multiply the ampereage by 1000 and place the red arrow on the product (10,950) as is done in Figure 3, when over the arrow "C" appears 7,000 circular mils, the area of wire required.

The same procedure is followed in deriving the carrying capacity of a wire figured at 1000 amperes per square inch, with the exception that the ampere reading (multiplied by 1000) appears over the "S" arrow.

Nineteenth Example: What is the carrying capacity of a wire having an area of 20,000 circular mils when figured at the rate of 1000 amperes per square inch?

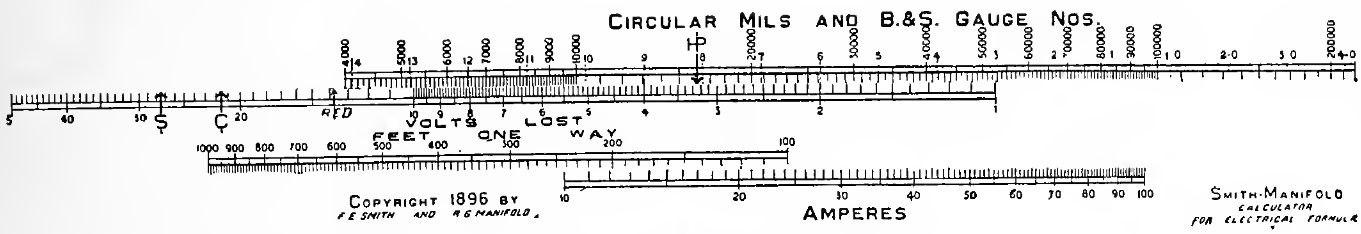


FIGURE 4.—THE SMITH-MANIFOLD CALCULATOR.

Proceed as in the Sixteenth example by placing the arrow "C" on 20,000 and over the arrow "S" read 15,700, which, when divided by 1000, gives 15.7 amperes, the required current. Hence:

Rule 4. To find the carrying capacity of a wire at the rate of 1000 or 2000 amperes per square inch: Place the arrow "C" on the circular milage of the wire designated, and the readings over the red arrow and the arrow "S," when divided by 1000, give the respective amperes the wire will carry at the given rates.

(To be continued.)

A NEW AGENCY FOR INTERIOR CONDUIT.

The California Electrical Works, 409 Market St., San Francisco, has been appointed Pacific Coast agent for the Interior Conduit and Insulated Company, and is prepared to fill without delay, from stock, orders in any quantity for plain, brass, armored or iron armored interior conduit.

This is but one of the many valuable agencies secured by the California Electrical Works, which is fast becoming recognized as the leading electrical supply house of the Far West.

FINANCE, POLITICS AND PROGRESS.

Promoters of electrical or other bonded enterprises who find that their efforts to interest capital in new developments are very arduous, if not almost impossible, because of the probability that the silver question will be reopened as the leading issue of the next Presidential campaign, and because, in consequence, of the still unsettled financial question, will be pleased to learn, on the authority of Finance and Commerce, a leading New York financial journal, that the Republican leaders at Washington are pushing the international bimetallic conference proposition to the front as rapidly as possible. The resolution authorizing President McKinley to appoint delegates to an international conference and to call such a conference, if necessary, which passed the Senate some time since, has been favorably reported to the House without a dissenting vote. This fact was the more noticeable because of the arguments against the resolution which were made before the Committee by representatives of certain business interests. The Republican leaders, it may be stated on good authority, have three distinct and very excellent reasons for pushing this proposition, and pushing it for very prompt action. First, that the party is absolutely pledged to it, and must, in good faith, carry out its pledges; second, that if the proposed silver conference is successful it will take the silver question out of politics, and thus reduce the business uncertainties which now exist; third, that if the conference fails to bring about a method of restoration of silver to its former relation to gold, this fact will show so clearly the impossibility of the United States accomplishing this feat alone, that the demand for the free and independent coinage of silver by this country will rapidly disappear, and thus the business uncertainty as regards the currency will clear away at the same time that the new tariff will improve the business situation in its own field of operations.

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EDITORIAL.

CONSULTING ELECTRICAL ENGINEERS

In the engineering world are engineers and—engineers. Similarly and in parallel application but in more significant strain, it has been said that in the mechanical world are "mechanics and—muck-anics, the latter being in vast predominance." Electricity has its full quota of engineers, many legitimate, many spurious, and as will ever be, the usefulness of honest effort suffers by the deeds of the irresponsible.

Should one attempt to grow an engineering tree, he would first plant the seed "engineer" in the soil of civilization, where, moistened by the water of industry and mellowed by the sunshine of progress, will shoot up a sturdy trunk whence bursts forth many branches known to all men by their characteristics. One branch is called "civil engineering," the next one "mechanical engineering," and other is named "hydraulic engineering," and still others, "steam," "marine," "pneumatic," "mining," or "electrical engineering," as are their tendencies. Each branch of this tree, like all others, is numerously divided and the electrical branch which broadly covers the world of electrical development, forks into the stalks of designing, supervising or consulting electrical engineering, whence emanate the limbs and lastly the fruits of electrical development, be they telephony, telegraphy, lighting, power, transmission, electrolysis or transportation. No branch bears the fruit grown on another, and the fruit is perfect only when the blossom is fertilized by pollen. So too, no man may acquire the highest skill in an art without making it his specialty and above all, his work is perfect only when the blossom of theory is blended with the pollen of practice. Without the knife of experience the tree darts up long shoots of aspiration which are frail and sap its vitality; without the pruning shears of education, it becomes scragly, outgrowing itself with the egotism of its own misdirected productiveness. Together experience and education trim each branch to the highest symmetry and fruition.

In general and from their very avocations, consulting electrical engineers appear as advisors on electrical matters. Hence in the eyes of the public they are seen as parties who "know all about" the applications of electricity whatever be their trend. The acquisition of universal knowledge concerning things electrical is impossible, hence it may be contended that the person who, of his own will, adds "electrical engineer" to his name, perpetrates a fraud upon the public in that he assumes to shine in a false light. Not so with the graduate of a duly accredited institution of learning, whose diploma awards him with an electrical engineership, in that he has completed the course of electrical engineering proscribed by the college and therefore has learned everything electrical that that college is capable of imparting, or with the pioneer who, being as a father of the "infant science" has marked and guided the course of his child from its uncertain footsteps of twenty years ago to its robust development of to-day. He, above all others, may, if he so elects, add the symbolic "E. E." to his signature and none will gainsay the propriety of his so doing. Who will question the right of Preece, Kelvin, Thomson, Edison or Tesla to assume the title of electrical engineer, or who will grant the same right to Jeremy Jones, inventor and locksmith, even though he be a centenarian and knows the electrical business to his own satisfaction? Or, again who will grant it unquestioned to the one whose an eminent position in the electrical world, first to a acquiring of an eminent position in the electrical world, is due first to a superficial knowledge of electricity, then to priorty in the field, next to his own artfulness and finally to personal influences and the ignorance of the public concerning matters electrical. Such an instance is not without parallel, be it said with shame.

There is little to be said regarding designing and supervising engineers except that the titles are plain, honest, straightforward. They profess to design electrical machinery or to supervise its installation and no more. Both owe their ability to study and long experience and all honor to the integrity of their titles, but of late it must be said, even though the just suffer with the unjust, that consulting electrical engineering has in the Far West, at least, received a set-back in that the consulting electrical engineer is becoming to be looked upon as a middle-man in the electrical business, as the man who oft-times preys upon the ignorance of capitalist or corporate manager for employment, and who, having acquired authority, uses it sometimes to the injury of both his employer and the contractor, more often to the detriment of the latter. Of the consulting engineer, therefore, words of endorsement may not always be given. When vested with authority he

oft-times becomes an autocrat, heedless of the admonitions of the wiser heads of the parent companies and without regard for the consequences of the follies that his own inexperience leads him to commit. All suffer from his employment and none profit thereby. May this criticism call forth consideration for the just as freely as it utters condemnation for the unjust.

On the Pacific Coast there has been no field of electrical engineering more prolific of strife of this nature than that of transmission plants, and the truth should be heralded that no other lines of electrical work so little requires the services of the consulting electrical engineer as that of the electrical transmission of power. The consulting engineer who, three years or so ago, had the audacity to inveigle capital into employing him for the knowledge he possessed or, rather, for the knowledge he assumed to possess, concerning electrical transmissions, was an arrant imposter, who had at that time never seen a transmission plant and whose only semblance of knowledge concerning one were the few crumbs of information that the designing engineers of the great parent companies had permitted him to pick up from their banquet tables of experimenting. They alone knew, of their own observation, of the hopes and fears with which the electrical transmission of energy was entered upon; they alone experienced the trials and tribulations of early defeat; they alone fought the fight and won the battle over the laws of nature that gave electric transmission commercial feasibility; they alone understood the forces to be handled and the methods yielding control of those forces, and they alone were possessed of the only experience that man had yet had concerning this, the newest, and, in some respects, most noteworthy achievement of the science.

Was it not then with supreme presumption, abetted by a keen perception of future business, that the experience-less consulting electrical engineer glibly charmed his way into the good graces and employment of prospective transmission companies? Again, it is repeated, the consulting electrical engineer of that period was an arrant impostor, and it may be added that transmission projects of to-day stand as little, if not less, in need of his services as then. The Portland, Redlands, Fresno, Santa Cruz, Newcastle and Bakersfield transmission plants attest this. The electric transmission of energy is a creation of such concerns as the General Electric, Stanley and Westinghouse Companies—concerns with whom reputation and motives of self preservation are of infinitely greater influence than the peurile and annoying criticisms of veneered engineers.

Not so, though, with the supervising engineer, who, as stated, occupies his legitimate sphere in a legitimate way. His title explains his office; he should not necessarily take part in the awarding of contracts, for the purchaser must soon learn, if he has not already done so, that any responsible electric company will faithfully execute at least all that it agrees to do. In brief, the supervising engineer is an installing engineer who relieves both purchasers and parent companies from innumerable details that would otherwise prove an embarrassment to the one and a burden to the other. One need not look further than the Riverside transmission to the south or the Copley transmission to the north, to see illustrations of the usefulness of the supervising engineer, but to the consulting electrical engineer, transmission interests of the Pacific Coast may well bid adios.

HIGH POTENTIAL SWITCHBOARDS

It is with considerable satisfaction that reference is made to the leading article of this issue from the pen of so practical an engineer as Mr. C. E. Dutcher. Indeed, in these times it is custom for the theorist or the advertising agent, rather than the practitioner, to monopolize the columns of the electrical press, hence an article such as Mr. Dutcher has presented is doubly refreshing in that it is the fruit of practical experience and in that it represents conditions as they exist in fact and not in mental structure.

The admirable description given of the circuit connections of the Fresno transmission plant leaves nothing to be said concerning the electrical details of construction of high potential switchboard equipments. The manner of building generators and transformers for all classes of work has been exhaustively described in text book and technical press, and is generally understood, and now that Mr. Dutcher has made clear the inner workings of the plant which at once embodies several of the most noteworthy achievements in electrical transmission, there is no longer a cause for misunderstanding the practical details of switchboard and transmission installations. The article is one which all may read with profit.

Passing Comment

An Editorial Review of Current Events and Contemporary Publications.

THE VALUE OF COLLEGIATE TESTS.

The Wisconsin Engineer, a most excellent quarterly issued by the College of Engineering of the University of Wisconsin, takes issue with an editorial on the above theme which appeared in The Journal of Electricity for August last, in which the practice of publishing the results of comparative tests of commercial apparatus and withholding the names of the makers, was criticized adversely. Without receding from a belief therein implied to the effect that it would be to the advantage of the electrical public if it could be advised of the names of the makers of the appara-

tus tested, we must hasten to assure the Board of Editors of our valued contemporary that the editorial in question was not aimed at the University of Wisconsin, or to any other institution or organization, but that it was directed solely at an almost universal practice which was and is believed to be a subject of adverse criticism. True, the idea threading the editorial was suggested by the appearance of Mr. Ford's "Complete Test of Modern American Transformers" in the Bulletin of the University of Wisconsin. This thesis contained exhaustive data upon the efficiencies, etc., of transformers, but the information loses much value to central stations and installing engineers because of the fact that the names of transformer makers are suppressed. Upon reflection and viewed from the standpoint of pure scientific research, the criticism will be construed by some as unfair; but from the standpoint of the commercial considerations of the many, which after all brings the greatest good to the greatest number, it must be admitted that the contention is a valid one. Nevertheless, let our good friends of the University of Wisconsin be assured of the high esteem in which they are held, individually and as an institution, and above all, let them not take umbrage at a well meant thought that hinges solely upon the point of view.

However, the question involved is one of more than passing interest, hence it is well that the reader may form his own conclusions. After reviewing the editorial referred to, the magazine contiues:

"In the first place we do not agree with the Journal that college instructors should be our guides in determining the best engineering practice. We will leave that duty to the practicing engineers of the country and ask of the instructor that he keep informed as to the best practice and teach it to the engineers of the coming generation. To do this, his laboratory must be equipped with modern appliances, which he should consign to the historical corner as the mould begins to gather. How is he to get modern apparatus? Will the University buy them? Any one who knows the tendencies of the board of regents to limit the apportionment of funds for the engineering department to that of the less expensive departments, will appreciate the difficulty of getting apparatus in this manner. The only other solutions of the problem are to enlist the sympathy of some beneficient millionaire, or else to establish such a reputation for the department that every manufacturer that wants an unbiased test of his product selects that institution to do it. The latter course is precisely the one Wisconsin has pursued. Manufacturers are receiving daily applications from universities and colleges all over the country for apparatus, and their waste baskets fairly groon under the weight of letters from learned professors and enthusiastic students. However, when a Wisconsin instructor or student wants to make a test his application is placed on file and carefully indexed and the desired article is shipped prepaid on the next express. A pleasant letter is sent to the applicant wishing him success in his undertaking and requesting that in case of publication, the identification of the result of the test on this particular piee of apparatus with the maker's name, be left entirely to the discretion of the latter. He knows about Wisconsin's tests on transformers, on alternating current motors, on steam injectors, and a dozen other things; he knows that the transformer tests caused many reputable manufacturers to change their design; that the late tests on alternating current motors indicate a like result; that the injector tests point out the particular field for each type of injectors, and that perhaps he likewise may be put on the right track; or, if already there, he wants a check on the work of his own men and a recommendation from an unbiased institution of reputation. We do not call this purchasing silence.

"Now let us see about the benefit of these tests to the community. What engineer would advise his company to buy the apparatus of Jones & Jones just because that firm made a good showing in a comparative test of apparatus, which they knew would be tested? Here their success is only a criterion of what they can do; not what they do do. The name of the maker might as well, then, be omitted in the publication of results, and the value of the publication is this: first, it gives the standard to be expected from first-class apparatus, and second, the method of testing is given that a purchaser may himself make tests on his own goods before accepting them."

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

ROENTGEN RAYS AND PHENOMENA OF THE ANODE AND CATHODE: By Edward P. Thompson, M. E., E. E., with concluding chapter by Prof. Wm. A. Anthony. 12mo cloth, 190 pages, 60 diagrams and 45 half-tones. Published by D. Van Nostrand Co., New York, 1896. For sale by Geo. Webb Alexander, 401 Market St., San Francisco. Price $1.50.

Lord Kelvin, after receiving the book now under review, was so impressed with its sphere of usefulness in the scientific world, that evidently his appreciation could find most suitable expression in departing from a long fixed custom to the extent of writing the author lines of endorsement that, in the eyes of the scientific world, will be viewed as an expression of approval from the highest living authority. "I received it only a few days ago," wrote Lord Kelvin, "but I have already looked nearly all through it with great interest. I have seen enough to know that I shall find much most

useful information in it which will always be readily available because of the very excellent method and care with which you have given references to authors, dates and publications, and I am sure that all who are interested in the subject will find your book exceedingly valuable. All your statements with reference to anything I have done on the subject are perfectly correct."

After such an expression of opinion from so eminent an authority, there is little left the reviewer but to outline the scope of the work. Except with the ardent enthusiast in X-Ray experimenting, the public at large, and even to a great extent the technical public, has become rather surfeited with literature descriptive of Roentgen phenomena, and the confession is frankly made that Thompson's book has lain almost unopened on the reviewer's table for weeks for the reason stated. To make the confession complete, however, it must be added that these weeks were, from the standpoint of added information concerning the very important branch of technical knowledge, as a long period of darkness that is now almost dispelled. No one as yet grasps the science of radiography with clearness and distinctness, so to speak, as of the light of day, but all will find the dawn in Thompson's interesting work.

Roentgen Rays is written for the information and guidance of advanced investigators, more especially than for amateurs and spasmodic enthusiasts. Indeed, any work which, without qualification or qualm, makes commonplace use of such a word as "pentadecylparatatolylketone" is clearly not intended for the purposes of kindergarten instruction. The work is a laboratory rather than a workshop handbook and the experimenter in quest of detailed information enabling the construction of induction coils, condensers, Crook's tubes, fluoroscopes, sciascopes, or other paraphernalia of radiography, must look elsewhere, but if outlines and lessons of the researches of scientists from the earliest days are desired, here they will be found most admirably arranged and sufficiently exhaustive to enable an accurate technical understanding of the progress that has been made step by step toward a solution of the problems presented in the phenomena of the anode and cathode.

As an example, the author describes one of Tesla's experiments, showing the expulsion of material particles through the walls of a discharge tube and in order to illustrate the manner in which experiments are described, the following abstract is given:

"At quite a low vacuum and after sealing off the lamp, Tesla attached its terminal to that of the disruptive coil. After a while, the vacuum became enormously higher, as indicated by the following steps: first, a turbid and whitish light existed throughout the bulb. This was the first principle characteristic. Next, the color changed to red and the electrode became very hot in that case where the powerful apparatus was employed. The precaution to be taken is to regulate the e. m. f., to prevent destruction of the electrode. Gradually the reddish light subsided and white cathode rays, which had begun, grew dimmer and dimmer until invisible. At the same time the phosphoresecent spot became brighter and brighter and hotter and hotter, while the electrode cooled, until the glass adjacent thereto was uncomfortably cold to the touch. At this stage the required degree of exhaustion was reached, and yet without any kind of a pump. From the fact that the vacuum became higher and higher by the means stated, Tesla was very much inclined to believe that there was an expulsion of material particles through the walls of the bulb, where these particles, which were passing with very great velocities, struck the sensitive photographic plate, they should produce chemical action. He referred to the great velocities of projected particles within a discharged tube and to Lord Kelvin's estimate of the same, and reasoned that with high potentials the speed might be 100 kilometers per second. No stronger proof as to the expulsion of material particles could be desired than an operation in which the eyes can see for themselves that such an action must have taken place. It was extraordinary that a visible but fine hole was made through the wall of the tube and especially that no air rushed into the vacuum. On the other hand, the pressure of the air was overcome by something rushing out of the tube through the hole. The glass around the hole was not very hot, although if care were not taken it would become much hotter and soften and bulge out, also indicating a pressure within greater than the atmospheric pressure. He maintained the punctured tube in this condition for some time and rarifaction continued to increase. As to the appearances, the streamers were not only visible within the tube but could be seen passing through the hole, but as the vacuum became higher and higher, the streamers became less and less bright. At a little higher degree of vacuum the streamers were still visible at the heated spot, but finally disappeared."

The whole work is filled after this manner with descriptions of experiments, nearly half of which lead the reader up to the time of Roentgen's discovery. There are included among many others, the brilliant researches of Lenard, Hertz and Crookes, together with a host of later investigators that have followed Roentgen's lead. Throughout the work the author has adhered to the plan of German investigators in publishing accounts of their experiments by means of numbered paragraphs containing numerous cross references, and the reader finds that the idea wonderfully facilitates his endeavors to keep his memory refreshed. Credit is given to authors and publications from which extracts are made, but The Journal of Electricity has cause to complain that it alone fails to be properly accredited in bringing out exhaustively the interesting and original experiments of Dr. Phillip Mills Jones, which are briefly referred to.

Personal

Mr. J. W. Godfrey, "Genial Jim" of Habirshaw wire fame, agreeably surprised his many San Francisco friends by making them an unexpected visit week before last.

Dr. Thos. Addison has been tendered the position of General Manager of the Federal system of the City of Mexico, which recently passed into the control of a syndicate of South African multi-millionaires and which embraces the entire electric and railway interests of that city, but being loathe to leave this country, the offer was declined.

Mr. John S. Eastwood, whose portrait appears on this page and whose experience in the construction and

JOHN S. EASTWOOD.

operation of the San Joaquin Electric Company's plant at Fresno, Cal., has given him invaluable information concerning the longest distance high potential transmission plant in the world, is a very progressive young man and an active member of the "Hundred Thousand Club" of his adopted city. By profession a civil engineer, practicing mainly in and about Fresno County, he has had long familiarity with the water powers of the Sierras thereabouts, and when the wood had through commendable foresight, secured the water right which is at once both the largest and most available in Central California and which has now for a year past, been furnishing power for the operation of the San Joaquin Electric Company. The development of this plant, which is also noteworthy as operating Pelton wheels under the highest head of any other electric plant in the world (1410 feet), is largely due to the farsightedness of Mr. Eastwood and to the financiering ability of Mr. J. J. Seymour, President of the Fresno Water Company and President and Manager of the San Joaquin Electric Company. Though making no pretensions to electrical engineership, Mr. Eastwood has, perforce, acquired an excellent knowledge of electrical transmissions and his extended practical experience has given him a vast fund of most interesting and valuable experience in the art that, from present indications, will prove man's chief means of securing power when the coal fields shall have "gone dry."

Obituary

HARVEY LAMB LUFKIN.

It is a sorrowful task to record the death of H. L. Lufkin, one of the brighest, ablest and most agreeable personages that ever travelled in the interests of an electrical concern and than whom no salesman ever left a broader wake of friends to mark his tours throughout both East and West. Mr. Lufkin died in New York City on December 21st last, after an illness of but four days.

Born in Cleveland, Ohio, in 1857, Mr. Lufkin entered the electrical business when 24 years of age and in 1886 he became associated with Messrs. Curtis, Crocker & Wheeler in establishing the C. & C. Electric Motor Company and played an important part in introducing and developing electric power. He was one of the very first to operate electric motors on arc and incandescent circuits, despite of the strong opposition of the central station officials who looked upon the innovation as a dangerous experiment. That there was wisdom in his contention is now known and fortunately he lived long enough to see electric power distribution become a very large and welcome part of the business of central stations. He was a distinctive pioneer in applying electric motors to the operation of factories and mills to the displacement of line shafting, and also had the satisfaction of witnessing the success and general acceptance of this improved method.

His long prominence in the electrical field and his intimate relations with many of the best authorities in its ranks had endeared him to those who now mourn his loss, and those who knew him will most warmly appreciate the words of Prof. F. B. Crocker, who, in testifying to Mr. Lufkin's personality, stated that he possessed the rare combination of technical knowledge with great business ability, enabling him to accomplish results which would be impossible for a man having either one of these qualities alone. This advantage, together with his excellent judgment, prevented him from making the mistakes which are so common in the development of a new art, and gave him a power to foresee the probable directions of successful prog-

ress, two examples of this prescience having already been noted. Although enthusiastic as to the value and possibilities of electrical applications, his good sense told him just where to stop, and it often happened that he would advise against the use of electrical apparatus when he did not think that it had decided advantages over other means, even though the electrical method might be feasible. Mr. Lufkin was a very active member of the National Electric Light Association. He was an associate member of the American Institute of Electrical Engineers, and was a leading spirit in organizing and making a pronounced success of the Electrical Exposition held in New York City during the spring of 1896.

Possessing an unusually bright and agreeable personality, he was universally popular among electrical men, and was sincerely liked by his friends and business associates. His sudden death in the prime of his ability and usefulness is a great loss to the electrical industry, which always requires the services of men of exactly his stamp.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

SAN DIEGO'S ELECTRIC BAKERY.

William Hilts, proprietor of the Detroit Bakery, 1154 Fourth St., is the first manufacturer in San Diego to introduce electricity as a heating and cooking agent. When seen last night he said nothing could beat its work. He had baked bread, cake, pies and everything used by him with the new heat, and found it the most perfect of anything he has ever used. The entire work of the bakery is done by the aid of this powerful agent. A motor runs his kneading machine, carries the dough to the oven on cars, lights his room, and last of all cooks the dough. The plant is one put up by Electrician Earl Richardson, of the Traction Company, the current being furnished by the plant of that Company. The bottom of the oven is lined with wire-covered-heaters, which generate heat at such a rapid rate that it takes only a few minutes to heat the entire oven. The generators are also being made for his largest oven, capable of baking 200 loaves of bread in one batch.—San Diego Union.

INTER-URBAN ELECTRIC ROADS IN SOUTHERN CALIFORNIA.

Some extensive electric railway building in this section will be done during the coming year. At the present time there are two agents of Eastern capitalists in this city looking over the field and making plans for future operations. So far, however, no more than a mere outline of what is contemplated is hinted at. These representatives from the East consider this a great field for investment. They are satisfied that there will be an enormous influx of people to Southern California during the next five years. And this population will go to the country and small suburban towns. This is how the railroad people argue. Electric roads have been a great boon to people who prefer to live outside the the large cities. Rapid transportation at all hours of the day and night has made it possible to have a home in the suburbs and do business in the city. The electric road to Pasadena and Santa Monica illustrates this idea very forcibly.

A move is on foot to electricize the horse-car line between the Soldiers' Home and Santa Monica. Work will commence at an early date. The proposition to put a road through to La Canada and around by Glendale is more than likely to result in something tangible. The projectors have had considerable encouragement from people who own property along the proposed route. The country is but sparsely settled as yet, owing to the lack of transportation facilities; but with an electric road there would be great inducements offered to home seekers. La Canada is one of the most picturesque and healthful sections in this whole region. The soil is all that could be desired and there is an abundance of water.

Some time ago there was gossip to the effect that an electric road was under consideration between Los Angeles and Whittier. The dull times and tightness of the money market choked off the enterprise. But the scheme has again been revived. Then there is that belt line that is to take in Long Beach and San Pedro. That proposition is not dead by any means. In fact it is more alive than ever before. The people back of this enterprise declare the line will be built before the end of two years.—Los Angeles (Cal.) Express.

Reports of the Month.

LITIGATION.

Los Angeles, Cal.—The Los Angeles Electric Co. has sued Chas. Bauer of the Anhauser saloon for $200. alleged to be due for breach of an electric lighting contract.——A similar suit for like amount has also been brought against the McInnes Bros.——T. J. Henderson, administrator of the estate of Charles C. Odell, has been ordered by Judge Clark to accept the sum of $2,890 from the Los Angeles Electric Railroad Company for the killing of Charles Odell some time ago.

Salt Lake City, Utah.—Lizzy Wolfley, a domestic in the family of R. M. Jones, has sued the Salt Lake & Ogden Gas & Electric Co. for $5,000, alleging injuries received by the potential of a 1140 volt primary circuit reaching the interior wiring through a defective transfomer.

INCORPORATION

Downieville, Cal.—The Downieville Electric Co. Capital stock, $25,000. Directors: R. Forbes, E. Macdonald, A. Denmire, W. V. Lockwood, R. B. Elder.

Los Angeles, Cal.—The Wybro & Lawrence Co. Capital stock, $50,000. Directors: H. C. Wybro, G. W. Lawrence Sr., Geo. W. Lawrence Jr., L. W. Boynton and F. W. Burnett. Objects: The buying, selling and manufacturing of machinery and electrical apparatus.——The Home Telephone Co. Capital stock, $50,000. Directors: F. W. Brawn, President: A. C. Cass, Vice-President; A. C. Jones, Treasurer: Louis F. Vetter, Secretary and John D. Works. Chas. E. Severance is General Manager. Objects: To establish a telephone exchange in this city using apparatus of the Standard Electric Telephone Company of Madison, Wis.——The Wright Wave Motor Co. Capital stock, $1,000,000. in 10,000 shares of $100 each. Directors: Parvin Wright, Shirley C. Ward, John S. Ward, K. W. Midowicz all of Los Angeles, and Jefferson Chandler of San Francisco. Objects: To acquire the ownership of wave motor patents, rights of water frontage and the generation, transmission and sale of electrical or other power created by wave motors.

Mendocino, Cal.—The South Park Railroad Co. Capital stock, $160,000. Incorporators: T. D. Riordan, E. Lande, J. J. Quinn, J. M. Hanley and F. H. Ransom. Objects: To build three miles of railroad along the windings of the South Fork of Flynn and Albion Creeks.

Napa, Cal.—The Sonoma County Land & Power Co. Capital stock, $100,000. Incorporators: R. H. Warfield, Geo. Stone, B. M. Spencer, M. W. Griswold and J. F. Byxbee. Objects: To

supply power and light to Napa, Mendocino, Lake and other counties.

Nogales, Ariz.—The Duquesne and Nogales Telephone and Telegraph Co. Capital, $5,000. Directors: J. S. Tebbits, Wm. Roy, Edward Titcomb. Objects: To construct, maintain and operate telephone and telegraph systems in Arizona.

San Francisco, Cal.—The Golden Gate Electric Co. Capital stock, $250,000. Incorporators: F. G. Cross, Geo. E. Whitaker, C. M. Cross, M. O. Robinson and B. J. Parker. Objects: To purchase and lease real estate and to erect suitable buildings for the purpose of supplying electricity in this city and vicinity.—— The Acme Electric Manufacturing Co. Capital stock, $50,000. Incorporators: W. T. Y. Schenck, L. St. D. Roylance, S. B Peterson, F. J. Dyer and W. S. Schenck.

Woodland, Cal.—The Washington Water and Light Co. Objects: To furnish this town with water and electric and gas light.

COMMUNICATION.

Carson, Nev.—The press dispatches sent from Carson during the afternoon and evening following the Corbett-Fitzsimmons fight aggregated about 400,000 words. A force of forty operators was required to handle that amount of matter. The officers of the Western Union Telegraph Company consider that in getting the dispatches through to nearly every town, village and city in the United States and Canada in time for the newspapers, from such an out-of-the-way place as Carson, they performed a feat that has never been equaled in the history of telegraphy. Up to the time of the fight there was only one wire in Carson. It ran from Reno, a distance of thirty-two miles, where connection was made with the trunk wires along the line of the Central Pacific Railroad. That wire was sufficient for all ordinary service, but, of course, was totally inadequate to carry even the private messages in connection with the great fight. Superintendent Jaynes grasped the situation, and a month ago went to Carson for the purpose of arranging to give a perfect telegraph service. Eight additional wires were strung from Cason to Reno, and there the through lines were split. Operators at Carson worked direct with Chicago over the Eastern wires from Reno for as much as those wires would bear. Then as many more worked direct to San Francisco over the wires west, and here the matter was repeated to Eastern points over the Northern and Souhern routes.

Every word of the matter filed was carried through to the editorial rooms of the papers all ove America in time for publication in the morning. Most of the dispatches were for Eastern papers, and owing to the difference in time the dispatches were required in their offices at least three hours before the time the papers on the Pacific Coast went to press. That no complaints of late delivery were made is something of which Superintendent Jaynes is naturally proud.

City of Mexico, Mex.—The operators of the Mexican telegraph line have organized a brotherhood and the new society was duly inaugurated on February 6th. Mr. Augustin M. Chavez, Director General of the Federal Telegraphs in the Republic, was in the chair and delivered an appropriate address. The portrait of Mr. Juan de la Granda, who introduced telegraphy in the Republic, adorned one of the walls.

Los Angeles, Cal.—The Home Telephone Co. has taken offices in the Bradbury building and is canvassing the city for telephone subscribers. It promises to cut existing prices 50 per cent and to place wires underground in the business section.

San Diego, Cal.—The Southern California Mountain Water Co. has been granted a franchise under ordinance No. 415 conveying the right to install a telephone or telegraph system including poles, conduits, wires, cables or other conductors along certain streets.

Santa Barbara, Cal.—F. T. Buell has sold a right of way for a pipe line and telephone line across the Rancho San Carlos de Junata to Wm. H. Crocker.

Spokane, Wash.—The President of the Spokane & Columbia Telephone and Telegraph Co., states that within the next six months Spokane and the British Columbia towns of Roseland, Trail and Nelson will be all joined by telephone. The new telephone line will probably follow the wagon road from Spokane to Rossland, and thence in the best route to Trail. A line will be built into the Slocan country during the summer by way of Waneta and Salmon to Nelson and other points, to reach all the principal towns in the Boundary and Slocan districts.

ILLUMINATION.

Anaheim, Cal.—On March 11th, the city Trustees rejected all bids for the proposed municipal lighting plant and instructed their supervising electrical engineer, E. C. Sharpe of Los Angeles, to draft new plants and specifications for the work.

Arroyo Grande, Cal.—The Board of Directors of the Templeton Milling Co. aredesirious of learning whether an electric light plant would be a paying addition to the mill.

Astoria, Or.—The Council is discussing the feasibility of a municipal lighting plant.

Baker City, Or. The Baker City Elec. Light Co. is installing a 150 kw. monocylic generator including all station instruments and

Belvedere, Cal.—Signatures are being obtained for the establishment of an electric light plant.

Benicia, Cal. Ordinance No. 45 has been passed granting a franchise to the Solano Electric Light & Gas Co.
transformers.

Ben Lomond, Santa Cruz, Co., Cal.—Thos. L. Bell has installed an isolated incandescent plant run by water power for lighting the cottages of his summer hotel.

Cnetralia, Wash.—An extension to the electric lighting plant is contemplated.

City of Mexico, Mex.—The Mexican General Elec. Co. has closed a contract for a plant for the city of Hermosillo, Sonora.

Ellensburg, Wash.—A proposition is being considered by the question of an electric light plant.

Emeryville, Cal.—The Oakland Gas, Light & Heat Co. has petitioned for an electric light franchise.

Etna, Cal.—The April meeting of the Board of Directors of the Etna Development Co. will probably take definite action on the city Council for transforming the electric light plant from steam to water power, which will effect a saving of $250. per month. It is believed that the Damman water power and mill property can be bought for $9,000, in which event the cost of the change will be about $13,000.

Fresno, Cal.—The La Favorita and Paragon vineyards are to be lighted by electricity from the circuits of the San Joaquin Elec. Co. E. D. N. Lehe of Stockton has secured the contract for the wiring and it is stated that the vineyards are 45½ miles distant from the power house.

Fullerton, Cal.— This town is aspiring to an electric light plant.

Healdsburg, Cal.—The new city water works will probably be run by steam power for the reason that the boilers could be used for an electric light plant should the city so desire.

Johaanesburg, Cal.—G. W. Chrisman of the Ventura Elec. Light & Water Works contemplates putting in an electric plant here for both power and lighting purposes.

Kamloops, B. C.—Jas. Delany has sold the electric lighting plant to Wm. T. Stewart.

Los Angeles, Cal.—The West Side Lighting Co. has applied to the Council to be relieved of the license of $100 per month required by ordinance from all electrical lighting companies doing a business of $250, a month and over.

Riverside, Cal.—The municipal plant is now operating above 2,100 commercial incandescent lights.

Medford, Cal.—Jas. Anthony of Butte County, Cal. is in this city with a view of locating an arc electric light plant.

Mercur, Utah.—Orders have been given to install an electric light plant in the Mercur mines.

Nogales, Ariz.—The Nogales Electric Light Co. has just installed a new 100 h. p. Corliss engine and two 1,000 lighters.

Nelson, B. C.—The Nelson Electric Light Co. contemplates ex-

tensive improvements and additions to its plant during the next 60 days.

Phoenix, Ariz.—The Phoenix Light & Fuel Co. have been granted a gas franchise.

Payson, Utah.—The Payson Elec. Light & Manfg. Co. has assigned, making T. G. Wimmer assignee. The assets are placed at $8.050, and the preferred credits are $2,358.60.

Pleasanton, Cal.—John Thiesen has applied for an electric light and water franchise.

Porterville, Cal.—W. H. Norris and Adolph Willson have been granted a lighting franchise.

Pasadena, Cal.—The Council is considering the advisibility of bonding the city for $10,000 for the purpose of installing a municipal lighting plant.

Pullman, Wash.—H. J. Jackson has applied for an electric light franchise.

Prescott, Ariz.—A municipal plant costing $6,000 is talked of.

Sacramento, Cal.—A special committee appointed by the Board of Trustees to investigate the cost of installing a municipal lighting plant has reported that such an installation would cost $40,000 and the recommendation was made that the corporation council be instructed to draft an ordinance for submitting the proposition to the people at a special election.

Salem, Or.—The Trustees and Superintendent of the Oregon State Insane Asylum have recommended an extension of the electric lighting plant and the installation of a storage battery in that institution.

Salt Lake City, Utah.—Mr. Dignowitty, a mining promoter of this city, has located a mill site on Bullion Creek, where a lighting installation will be placed.

San Diego, Cal.—Mr. E. C. Sharpe the well known supervising electrical engineer of Los Angeles, has made a proposition to the City Council to build a first class electric lighting plant for the city with all the latest improvements and let the city pay for it in installments covering a period of five years. The matter has been taken under advisement.—The Theosophists propose to install an electric lighting plant for lighting the temple and its adjoining buildings and grounds. Ernest Hargrove is President.

San Francisco.—Supervisor Rottanzi is favoring the installation of an isolated lighting plant in the City Hall.

San Pedro, Cal.—It is reported that the Long Beach and San Pedro Electric Light Co. will move its plant from Long Beach to this place in April.

Selma, Cal.—A mass meeting of citizens has passed a resolution showing it to be the sense of the meeting that the town be bonded for $15,000 for the construction of a light and water plant and a committee consisting of J. A. Burns, H. G. Drew and J. W. Aiken were appointed to determine the cost.

Shalam, N. M.—A. M. Howland is to make a health resort of Levitica and among other improvements will install an electric light plant there.

Silver City, N. M.—M. W. Neff is arranging to install an electric light plant here.

Sitka, Alaska.—California parties are endeavoring to organize water and electric light works here.

Spokane, Wash.—City Commissioner J. T. MacLean is urging that $45,000 be expended in increasing the 1,500 h. p. pumping plan now used by the city water system, to 3,000 h. p., which will permit the installation of 2 additional pumps and the addition of an electric light plant that would furnish three times as many street lamps as are now in use. He estimates that the city would save $3,700 a year by the change.

Stockton, Cal.—The Stockton Gas & Elec. Co. is at work on plans for the new power house, and the new works when completed will be run by gas engines.

Ukiah, Cal.—The Mendocino Elec. Light Co. has been granted a lighting franchise.

Ukiah, Cal.—A new company consisting of W. S. Lockwood, P. S. Taylor, Frank Morse, W. A. Hagans and T. A. Templeton is to install an opposition electric light plant here; the company is capitalized at $20,000 of which $12,000 is paid in.

Vancouver, B. C.—The new Selevor smelter to be erected here will be lighted by electricity.

Whittier, Cal.—A combined electric light and ice plant is under consideration.

Williams, Ariz.—The Saginaw Lumber Co., which is rebuilding its immense mills at this place, will light them by electricity.

Woodland, Cal.—The Washington Water & Light Co. have applied to the Board of Supervisors for a franchise and right of way in the town of Washington.

TRANSMISSION.

Bakersfield, Cal.—The first trial run of the generators in the power house of the Power Development Co., was made on February 17th, and a few days thereafter the plant was placed in successful operation. The equipment of the plant has been described in these columns. All apparatus is of General Electric make.

Great Falls, Mont.—The Boston and Great Falls Electric Light Co. has contracted to furnish electric power for a term of years for the operation of the Silver smelter, and as a result the plant of the electric light company is to be increased.

Mesa, Ariz.—Dr. A. J. Chandler, Supt. of the Consolidated Canal, is making satisfactory progress in the development of the water power. Five hundred horse power is now available with a fall of 39 feet which can be easily increased to generate 800 horse power. This power will doubtless be used by electrical means for pumping water into the irrigating canals.

Monterey, Cal.—On April 14, the Monterey Power Co. will open bids for the installation of its entire plant including dam, flume, wheels, electrical apparatus and pole line from Little Sur River (22 miles south of Monterey City) to Monterey and Salinas City, for the generation and transformation of electrical current of not less than 450 horse power; entire distance being approximately 37 miles. Major Phillip P. Dandridge, a civil engineer late of Redding, is to have charge of the work which it is expected will be completed late in August. The construction will include 9,600 feet of fluming, which will furnish 2,000 inches of water at a head of 210 feet.

Oakland, Cal.—The most promising scheme yet broached for the transmission of power to Oakland or San Francisco, is that developed by Dr. Thos. Addison, Manager of the Pacific Coast office of the General Electric Co., which consists in placing a steam plant at the coal mines of Corral Hollow and transmitting the power to Oakland, 42 miles. The present plans call for the transmissions of 6,000 horse power, but the transmission company has a contract with the Corral Hollow mines by which the latter agree to furnish enough coal either waste or merchantable to generate 10,000 horse power continuously. The capital for the installation has been secured but it is deemed advisable to await a demonstration that the coal mines will be able to furnish the amount of fuel contracted for. It is stated hat the Oakland Gas Light & Heat Co., and the Alameda Railroad have agreed to take power and no doubt is entertained that other electrical enterprises will find transmitted power cheaper than it will be possible to generate.

Portland, Or.—The Portland General Electric Co. has concluded to extend Station B at Oregon City, which contains the three-phase General Electric plant described in the "Journal of Electricity" for December, 1895, by the addition of two sections. This is in addition to the 12 foot extension which has lately been completed and the new extension will be 32 feet long conforming with the remainder of the structure. The projected extension will include two sections, and be 32 feet long, built the same as the remainder of the structure. The first part completed was 80 feet long, so the extension to be made will make the structure 124 feet in length, with 14 sets of turbines, each set operating a 600-

horse power dynamo, except the set that actuates the pumps. Further extension of the power house will be made as soon as the power is needed. The division wall between the boat canal and the feed channel for the power house is now being built. It must be anchored to the solid rock toward the bluff, to do which it will be necessary to let the water out of the canal.

Santa Cruz, Cal.—Mr. and Mrs. F. L. Robinson have sold their interests in the Big Creek Power Co., to F. W. Swanton and the present owners of the company are Wm. Rennie, Henry Willey, F. W. Swanton and wife, A. P. Swanton, A. A. Morey of Santa Cruz and Mayfield Smith of San Jose.

Redlands, Cal.—One of the most ambitious electrical transmission plants yet proposed and which appears to be one that will first be realized is that of the Southern California Power Company of this city, which has been recently organized by Henry Fisher, President of the Fisher Oil Company of Pittsburg and H. H. Sinclair, President of the Redlands Electric Light and Power Co. The company, which has $1,000,000 capital, proposes to develop the power of the Santa Ana river by taking water out at the junction of Bear creek and Santa Ana river, carrying it in a cement ditch and tunnels about four miles, thus securing a fall of from 1,000 to 1,100 feet, and then returning the water again to the stream. The amount of power will be 1,000 horse power. This will be transmitted by a pole line 75 miles to Los Angeles, there to be used to supplant the steam power now used to develop electricity for the lighting companies and street railroad companies. It will be the longest line and handle the highest voltage (30.000 volts) in use in the world. The line will supply San Bernardino, Pomona, Ontario and Pasadena, and the company will be independent of the present Redlands company, but will work in harmony with it, especially as to interchange of power when necessary. The Redlands company now has 1,000 horse power in machinery installed at its power house on Mill creek, and has just bought enough land in Mill creek canyon to enable it to develop 15,000 horse power more. Work will be begun in Santa Ana canyon as soon as surveys are completed, which will be about April 1. It is proposed to deliver power at Los Angeles by January 1, 1898. The Company has already closed a five-year contract with the East Riverside Irrigation Co. to supply it with electric power for pumping purposes and its officers are at present negotiating for the supply of electric power to the various electrical enterprises in San Bernardino.

San Bernardino, Cal.—The San Bernardino Electric Light Co. is to increase its capital stock from $50,000 to $100,000, which will enable the acquiring of the East Riverside Water Power plant having a capacity of 250 horse power, which, together with the 150 horse power in water power available from the Kehl ditch at the present plant, will give the company 400 horse power in water. In addition arrangements have been concluded with the Redlands Electric Light and Power Co., by which an additional 500 horse power can be secured when desired. Among the other extensions considerable street railway work is contemplated.

Marysville, Cal.—F. W. Page has applied for an electric lighting and power franchise which is to be operated in conjunction with the system he proposes to install for lighting Marysville, Yuba City and the surrounding Brown's Valley country.

Mokelumne Hill, Cal.—Some very thorough work is being installed at the power house of the Blue Lakes Company. The structure is of steel measuring 35 by 150 feet, resting on a foundation of solid rock and concrete. A 10 ton travelling crane has been placed therein for handling machinery which will consist of three 450 kw Stanley two-phase inductor generators to be direct driven by P tangential water wheels made by the Abner Doble Company of San Francisco. The wheels are to be quadruple nozzle and to be driven under a head of 500 feet.

MISCELLANEOUS.

East Helena, Mont.—The United States Smelting and Mining Co. will introduce the electrolytic process in its works.

Los Angeles, Cal.—Hugh T. Duff and Geo. E. Nolan have formed a co-partnership known as the Machinery and Electrical Co., and as such have succeeded to the business of the Machinery Supply Co.

Sacramento, Cal.—Governor Budd has vetoed Senate Bill No. 9 which was designed to grant to the Trustees of the cities of Alameda, Berkeley and others in the same class, power "To purchase, lease or construct water works and electric plants, and all machinery, conductors and appliances necessary therefor and to supply such city with and to sell to the inhabitants thereof, water, light, heat and power, etc." The Governor maintains that the questions involved should be submitted to the vote of the people.

San Francisco, Cal.—Local Union No. 6 of the National Brotherhood of Electrical Workers has elected the following officers: Past president, D. Keefe; president, A. C. Johnson; vice-president, G. P. Manning; treasurer, D. Keefe; financial secretary, J. R. Fulton; recording secretary, J. J. Cameron; foreman, H. W. Pierce; inspector, J. A. Barnhart.

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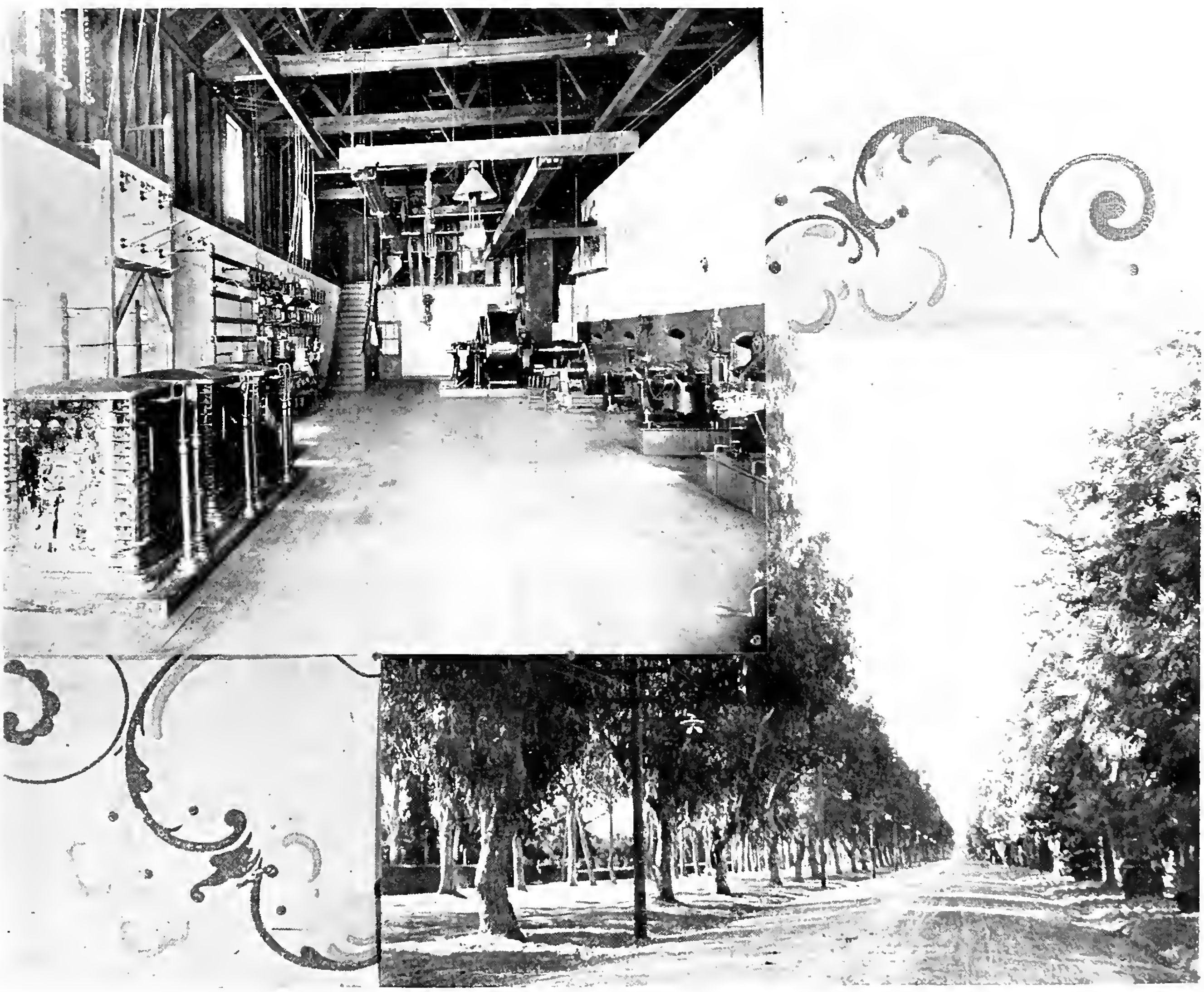
The Journal of Electricity

VOL. IV. MAY, 1897. No. 2

The Riverside Transmission.

By W. A. LAYMAN.

On December 1st last there was turned over to the municipal authorities of the beautiful city of Riverside, Riverside county, Cal., from the hands of the California Electrical Works of San Francisco, an electric transmission and general distributing system for both power and lighting, which for completeness, novelty and general efficiency typifies in every sense of the word the highest development of the art as at present understood. This undertaking, so recently inaugurated, and so successfully pursued to completion, is, however, characterstic of the community, and but exemplifies in a new direction the same spirit of enterprise and energy which has transformed so quickly and so completely, this once almost desert



FIGURES 1 AND 2.—THE INTERIOR OF THE GENERATING STATION AND THE ELECTRIC LIGHTING OF MAGNOLIA AVENUE.

waste, into the paradise of luxuriant foliage, and fruit-laden orchards that it is.

A less progressive municipality than Riverside would probably not have attempted the transmission of electric energy a distance of twenty-two miles, and at a single step not only appropriated the energy of mountain streams for its especial municipal requirements, but also placed within the reach of all her residents electric power and light at rates against which there could be no commercial competition. And noteworthy also is it that from beginning to end no step has been taken without engineering advice looking to the employment of efficient and reliable apparatus.

FIGURE 3.—METHOD OF LINE TRANSPOSITION.

Concretely stated, the system in its entirety consists of the following general features: The energy supply is purchased direct from the Redlands Electric Light and Power Company, which owns the most accessible and available water supply. The Redlands Company, by contract, delivers to the city of Riverside at the switchboard of the generating station three-phase alternating electric current of 2500 volts pressure. This current passes through step-up transformers which change the pressure to 11,000, at which the energy is transmitted 22.4 miles over the open country to a substation in the city of Riverside. Here it is in turn again transformed by step-down transformers, to a pressure of 2200 volts. From the step-down transformers it passes to a distributing switchboard, and from the latter continues out over the general city distributing circuits, four in number, of which two are for street arc lighting and two are for incandescent lighting and motor work. On these street circuits, reducing transformers are again used, changing the pressure to 30 volts for the street and commercial arc lights, and to 100 volts for the incandescent lights and motors. From first to last the three-phase system of distribution has been followed.

The generating power house is located at the head of the beautiful valley in which are the towns of Redlands, Colton and San Bernardino, and is quite snugly hidden away in the foothills at the base of Mount San Bernardino. This plant, the first three-phase station to be established in the West, was started on September 7th, 1893, and has earned a world-wide reputation for its unbroken record of successful operation. The generating dynamos, which are at present two in number, are of 250 kilowatts each, and are of the General Electric three-phase, 6000 alternation type. As before stated, these dynamos deliver current to the switchboard at 2500 volts. Since the two machines are not always required, there are independent sets of bus-bars, and it is from either of these or both, as the case may be, that the energy for Riverside is taken.

The Riverside equipment accordingly begins with a marble panel on which are mounted three double-throw, single pole quick break switches of the California Electrical Works design and manufacture, by means of which current is thrown on a special set of three bus-bars feeding the step-up transformers. From these bus-bars the current passes through a panel of specially designed single pole fuse blocks to the three 100 kilowatt step-up transformers. These blocks are so made that the portion containing the fuse is separable, and perfectly insulated so that were it desirable to do so, the fuse could at any time be quickly removed from the circuit and as easily reinserted. Furthermore the blowing of any fuse is devoid of the burning of contacts, and the block is accordingly good for unlimited service.

Coming now to the step-up transformers, there is found probably the most decided innovation of the entire equipment. These, three in number, and of a capacity of 100 kilowatts each, were built by the Wagner Electric Manufacturing Company of St. Louis, under stringent requirements for efficiency. They are a radical departure from conventional practice, each being a series combination of two 1250 to 5500 volt units, encased in cast-iron, oil filled, water-jacketed boxes. They were designed to afford not only a higher degree of insulation safety, but a more economic use of materials and a higher operating efficiency at all loads than is possible with an air ventilated transformer. The insulating oil is of the highest quality, as shown by proof tests, to be had in the market, and is sent out by the Wagner Company under guarantee. The iron cases are built up in sections, each lateral member of

which is so cased as to give successive small channels confining the water to constant flow up and down as were there a continuous coil of pipe all around the transformer. The sections are cross connected in such a manner that all in all there is not possible any communication of the water and the oil. The water flow is from a gravity head of about 15 feet, and can be regulated at the will of the operator by means of globe valves in the outlet pipe of each transformer. The design is such that no cooling device whatever is required up to one-half or three-quarter load, and not until the apparatus begins to approach the full load does the temperature of the apparatus rise much above that of the atmosphere. Operating under one-third load without cooling device, the maximum temperature attained in a ten-hour run was but 100 degrees Fahrenheit.

Passing from the step-up transformers, the 11,000 volt current goes out through three single pole quick and long break switches, neatly mounted on a marble panel, to the transmission line. These switches are new, of special design, manufactured by the California Electrical Works, and are so arranged that the blowing of a protecting fuse automatically opens them. Immediately beyond the switches are the lightning arresters of the Wurtz pattern.

The transmission line is also an admirable feature of the system in the thoroughness and excellence of the construction. Three No. 4 bare copper conductors carry the current. These conductors are mounted on Locke triple-petticoated porcelain insulators, these insulators in turn being carried on the Locke iron pins. On the entire transmission line 3300 of these insulators have been used, and worthy of note is the fact that, aside from those mechanically injured in shipment, not a single defective one was found, nor in a single one has trouble in service subsequently developed. This statement carries no little weight with it, when to it is added the statement that there was recently experienced throughout Southern California; and immediately here in San Bernardino valley, the severest driving rainstorm of several hours' duration, with it an almost unprecedented amount of lightning, that has been known in years. Throughout this storm the system operated without interruption, a recommendation for the whole installation better than any guarantee that could have been given.

FIGURE 4.—ALONG THE POLE LINE FROM MOUNTAIN TO VALLEY.

For several miles the transmission line is carried upon the poles of the Redlands Company. It then passes to a special pole line on which it is carried into the city of Riverside. The poles of this special portion are 30 feet in height, 6 in. top, of cedar, and 110 feet apart. The cross arms are standard, and are doubly braced. Conductors are carried 18 inches apart between centers of pins. On entering the city limits the poles are increased in height to 40 feet, for two miles, then going up to 45 feet the remainder of the distance to the sub-station.

The sub-station is a neat, although unpretentious, single-story brick building, 36 by 30 feet in size, and occupies a rather central location in the city. The transmission line enters the east side, passing directly

to the high tension switchboard, which has single pole quick break switches exactly duplicating those on the high tension side of the step-up transformers. From this high voltage marble switchboard, which is about "3x4" feet, the 10,000 volt lines pass to three bus-bars, to which the step-down transformers are connected.

The step-down transformers, also of the Wagner Electric Manufacturing Company's design and build, are practically identical with the step-up transformers in general mechanical features, being oil-filled and water-jacketed. Their only difference is in the transformation ratio, and the capacity here being but 85 kilowatt units, instead of 150 kilowatts, as there, and having a reduction ratio of 5.

The step-down transformer secondaries lead direct of the main feeder panel. The current passes upward through these special fuse blocks to quick break single pole switches, thence to the Whitney indicating ammeters above, and then down to the three main bus-bars extending all the way across the board. Above the ammeters on the panel are three Whitney indicating volt meters reading through special resistance boxes direct on the full voltage on each phase of the main feeder circuit. The adjoining panel on the right is for the two three-wire arc lighting circuits. These circuits are fed from an auxiliary set of three bus-bars connected with the main bus-bars through a set of three fuse blocks and three single pole switches. Between the auxiliary bus-bars and the outgoing branches of the circuits are interposed single switches

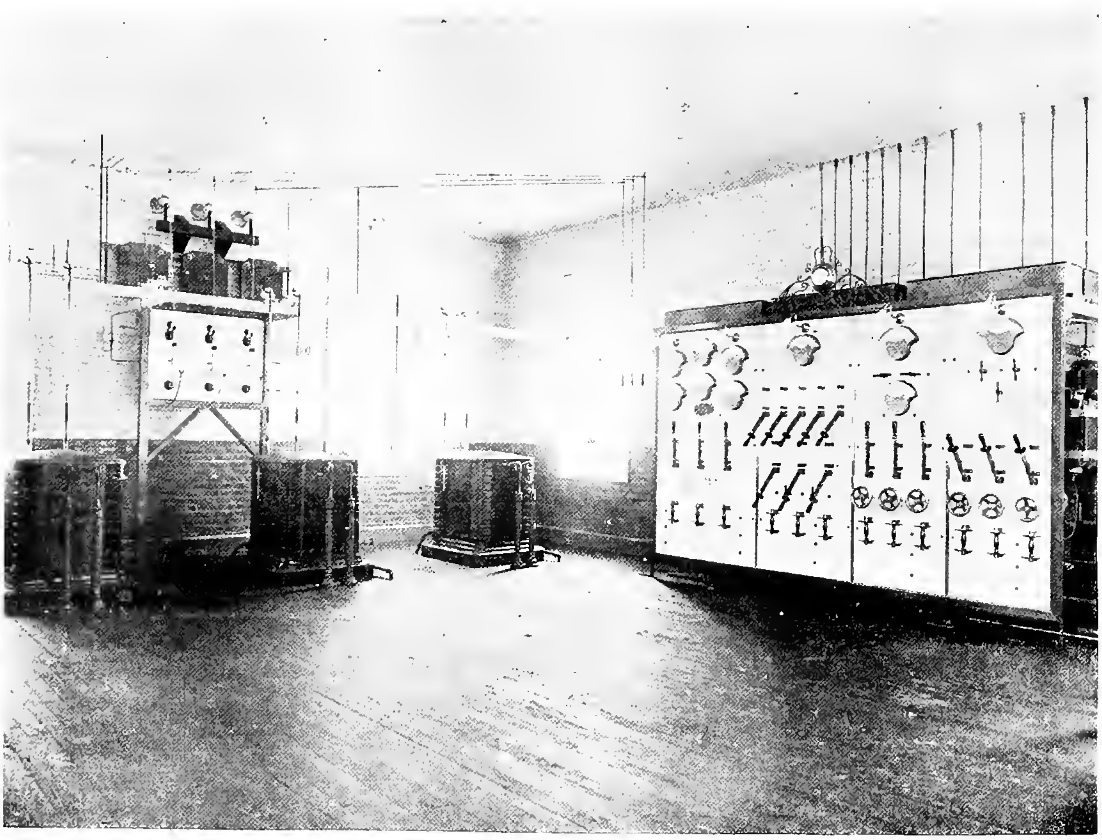


FIGURE 5.—THE SUBSTATION SHOWING LIGHTNING ARRESTERS, HIGH POTENTIAL SWITCHBOARD, TRANSFORMERS AND THE DISTRIBUTING SWITCHBOARD.

to the distributing switchboard of the general wiring system of the city.

The switchboard, 7 by 12 feet, and of Italian marble, is another example of the excellent design and thorough workmanship of the California Electrical Works. The front, with its numerous single pole quick break switches and polished brass encased indicating instruments, is very attractive to the non-technical visitor, while the rear, with its systematic arrangement of connections, distributing bus-bars and neatly outgoing circuits, is equally interesting to the engineer.

The step-down transformer secondaries, on reaching the board, are grouped in three-phase, interlinking on the rear projecting studs of fuse blocks at the bottom by means of which the arc load is divided up so that a small portion may be thrown on at any time. On this panel occupying a position above all the switches, is a single volt meter so arranged that it can be thrown on any two of the auxiliary bus-bars.

The third panel is for a three-wire incandescent circuit, feeding the western business portion of the city. Here again the current for each leg passes from the main bus-bar through special fuse block to a single pole switch above. Beyond the switch it passes through special pressure regulating transformers of the design and manufacture of the Wagner Electric Manufacturing Company, to the outgoing line. On this panel there is also a single Whitney voltmeter

and a single Whitney ammeter. The former is so arranged through small throw over switches that it can be quickly connected to either of the three phases of the outgoing circuit. The latter is so arranged that it may be plugged by means of special flexible leads in parallel with either of the three single pole switches below, and when so connected the simple opening of the switch in with it throws the current through the instrument. By this process a single ammeter is made to do the indicating both on this panel and the next, in all branches of the two circuits.

The fourth panel is identical with the third with the exception that where the ammeter is located on the third, there is here placed the ground detector switch. This panel feeds the resident incandescent district, and on this also the outgoing line pressure is regulated by means of three Wagner regulating transformers.

The six regulating transformers are designed to control the pressure of the circuits in which they are placed for variation of 10 per cent above or below the normal feeder pressure.

The sub-station interior, as a whole, presents a very neat and attractive appearance, being well lighted and ventilated, and the apparatus is so placed as to be not only free of access, but well displayed.

The construction work of the distributing lines as they branch out over the entire city is of the same thorough character as that of the transmission line. The poles are straight and well set, the cross arms strongly braced, and the line wires all drawn up taut. These distributing circuits comprise in all over 28 miles of pole line. The arc system for street lighting is everywhere entirely independent of the incandescent and motor service system.

For street lighting there are used 80, 2000-candle power Helios arc lamps, especially built by the Helios Electric Co. for this frequency. These lamps are fed from an equal number of 2000 to 30 volt Wagner oil filled transformers. No uniform method of suspension for these lamps has been followed. Some are suspended from substantial mast arms of the design of the Western Electric Company of Chicago. Some are intersection lamps, and others are neatly mounted on wrought-iron pole top brackets.

In addition to the street arcs, numerous 1000 candle power inside Helios' lamps have been installed. These are fed from the general incandescent service, Wagner economy coils, encased in ornamental brass cases, being used to reduce from 100 to 30 volts.

The incandescent service follows the conventional practice. Where requirements and conditions accommodate themselves, large transformers feed secondary bus lines, from which grouped customers are supplied. In other cases each customer is supplied from an independent transformer. The incandescent transformer service complete, as well as the arc, is of the Wagner Electric Manufacturing Company's apparatus.

A notable feature of the incandescent service is that meter service is in general use, wattmeters of the Schaefer design and furnished by the Diamond Electric Company, having been installed. These, by their extreme simplicity and reliability, are proving highly satisfactory.

The system in its entirety has been in operation four months, demonstrating through that time its success in every particular. Experts from many places have visited the city and made careful inspection, and the verdict has uniformly been that a more creditable equipment to the city and contracting engineers alike

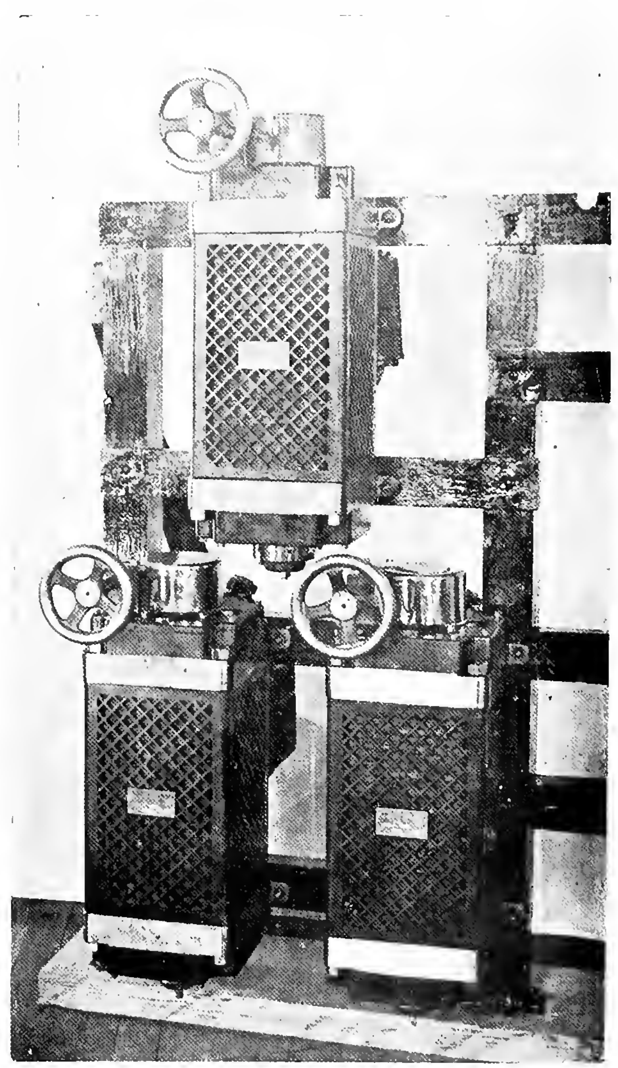


FIGURE 6.—POTENTIAL REGULATORS IN THE RIVERSIDE SUBSTATION.

could not have been secured. Especially satisfactory to the residents of the city is the beautiful effect produced on their world-famous "Magnolia avenue." The grand drive, so charming and beautiful by daylight, is now made even more attractive at night. Clusters of three incandescent lamps, carried by neat wrought-iron brackets, are placed at intervals of 125 feet upon poles carrying the feeding circuit. This line of fire certainly produces a fine effect and well may the Riverside people feel a pride in the results achieved.

The engineering interest for the city have been conscientiously and ably handled by Mr. E. C. Sharpe, a

young engineer of recognized ability all along the coast. He was engaged as superintending engineer early in the inception of the plan, and under his direction the work has been carried through to completion.

The contracting engineers, the California Electrical Works of San Francisco, have been represented in the field by Mr. A. J. Myers, under whose guidance, and after whose designs, the engineering work in every detail has been done.

The installation as originally contracted for was to have cost $40,978. Additional work will, however, bring this up to about $50,000. The Riverside Board of Trustees, to whom is due all the credit for the materialization of this elaborate and excellent system, is composed of the following representative citizens: E. F. Kingman, H. N. Bordwell, J. A. Sumers, B. Morse, S. Larue.

Educational

THE SMITH-MANIFOLD CALCULATOR—V.*

By Geo. P. Low.

It is well to point out at this time that the use of micrometer calipers affords the most accurate and reliable means for measuring the diameters of wires. It is accurate in that the diameter of the wire is read direct without reference to guage, hence measures absolutely while ordinary guages overlook odd sizes, and it is reliable in that any wear occurring in the calipers may be taken up and the correctness of the instrument proven. It is a universal method from which any gauge number may be derived, whatever be the gauge, and at the same time its use enables the determination of the shrinkage in size of a wire due to stretching or other cause. A No. 1 B. & S. line wire, after a term of use, will be reduced by sagging, so that it would be incorrect to still call it a No. 1 B. & S. wire. Instead it may have stretched to a No. 2 B. W. G. wire, and accuracy demands that it be so called.

The principle underlying the construction of micrometer calipers is a pretty one. In one arm of its U-shaped frame is tapped a screw running toward the other arm. This screw has forty threads to the inch and the number of threads passed are recorded on a suitable thread scale. The periphery of the milled head of the screw is divided into twenty-five equal parts. If the screw be sent home, its zero line meets the zero line of the thread scale and the opening between the screw point and the other arm of the frame is closed. Now turn the screw one division of the screw scale (not the thread scale), and clearly an opening has been made between the screw point and frame that will be one twenty-fifth of one fortieth, or exactly one one-thousandth of an inch in size. It is in this manner that the diameter of a wire in mils is measured.

Previous examples have shown the method of reducing square mils to circular mils, or vice versa, by use of the Calculator, but the reduction of mils to circular mils, or of circular mils to mils, though less simple, is equally effective.

Twentieth Example. — What is the diameter of a wire having an area of 70,000 circular mils?

* The figures herein referred to are those appearing in the previous articles this series.

In problems dealing in circular mils, the arrow "C" is used, while those dealing in square mils use the arrow "S." In the present example, the arrow "C" is placed on the area given, or 70,000 circular mils, and the slide is reversed after the manner previously described. A convenient mode of reversal with the problems in hand consists of observing the reading of any mark on the volts lost scale—assume say the 50-volt point—and by moving the slide to the left so that the 5-volt point is opposite the same mark, the slide is reversed. Any number or its multiple will do and 50 has been selected only because of its ready divisibility by 10.

Following this procedure, on placing the arrow "C" on 70,000 circular mils, the 50-volt point is opposite the 30,000 circular mil mark, and to reverse the slide the 5-volt point is moved to the position held by the 50-volt point which leaves the Calculator in the position shown in Figure 3.

Thus far the procedure is simple, but a little practice will be required before the student will acquire celerity in reading the diameter direct in mils from the point on the feet-one-way and the ampere scales where the reading on the former scale equals that on the latter scale multiplied by 10. The most ready plan is to assume that all ampere readings are ten times as great as actually appear on the scale—in fact, reversing the slide to the left has multiplied the ampere readings by 10. The 20 mark, therefore, has a value of 200, and so on.

Now let the eye run along the feet-one-way scale to the left, and along the ampere scale to the right, until a point is found where the numbers on the two scales are numerically equal. This point gives the direct value in mils of the diameter of the wire which, in the present instance, is 263 mils. The converse, of course, holds true in all instances and if the diameter of a wire in mils is given and it is desired to find the circular milage of the conductor, proceed as before but in reverse order.

Familiarity with the use of the Calculator may best be acquired by manipulating it in accordance with the rules given herein and comparing the results with a Brown & Sharpe's table of wire dimensions and properties. If the results derived from the Calculator do not tally with the table, the discrepancy may be properly attributed to inexperience on the part of the user, for the Calculator is infallible.

An intimation of the mode of finding the diameter of a wire when its area in square mils is known, is given in the statement made that the arrow "S" is used in problems dealing in square mils. The use of the "C" and "S" arrows, therefore, embodies the only difference in the modes of finding the diameters of wires whose areas are expressed in circular or square mils respectively, hence there is no necessity for further illustration by examples.

RULE 5. To find the diameter of a wire in mils, its area in circular mils being given: Place the arrow "C" on the circular milage given and reverse the slide, when the numerically equal readings on the feet-one-way and ampere scales will give the diameter in mils direct.

RULE 6. To find the diameter of a wire in mils, its area in square mils being given: Place the arrow "S" on the circular milage given and reverse the slide when the numerically equal readings on the feet-one-way and ampere scales will give the diameter in mils direct.

RULE 7. To find the circular milage of a conductor when its diameter in mils is given: Adjust the feet-

one-way and ampere scales so that their opposite points numerically equal the mils given, and reverse the slide when the arrow "C" will indicate direct the circular mils required.

RULE 8. To find the square milage of a conductor when its diameter in mils is given: Adjust the feet-one-way and ampere scales so that their opposite points numerically equal the mils given, and reverse the slide when the arrow "S" will indicate direct the circular mils required.

Relief from the seeming perplexities of the preceding examples will be had in determining the equivalents of wires by means of the Smith-Manifold Calculator. The perfect simplicity of this will be made apparent by the

Twenty-first Example.—What are the equivalents of a No. 3 B. & S. wire?

Place 1 volt lost on No. 3 wire as in Figure 4, when the remaining integers on the volts lost scale will show the number of wires of the size indicated directly over each such number, as will be required to form a strand constituting a No. 3 cable. Thus, in this example, the equivalents of a No. 3 wire are: two No. 6's, four No. 9's five No. 10's, etc.

RULE 9. To find the equivalents of any size of wire, place 1 volt lost on the size of given wire and the number of volts expressed under any other size of wire will show direct the number of such wires that will give a combined area equalling that of the given wire.

The above rule finds a ready adaptation in finding the sizes of stranded cables. For instance—

Twenty-second Example.—A cable contains ten No. 13 B. & S. wires. What is its B. & S. gauge number?

Place the number of wires as shown on the volts lost scale on the size of each such wire shown in the C. M. scale, when over 1 volt lost will appear the gauge number of the strand.

The simplicity of the problem makes a demonstration unnecessary beyond noting that its solution is found in the setting of the Calculator appearing in Figure 4.

There has now been given in an elementary way the outlines of the scope of the Smith-Manifold Calculator as a ready solver of problems that daily arise involving electrical and dimensional data of wires. The first-named involves modifications of Ohm's law as applied in the simple circuits most readily exemplified in ordinary wiring work and the student who finds the relations existing between voltage, current and the size of wire to be a source of unending perplexity will realize in the Calculator a most ready means for clearing the enshrouding mystery.

Personal

Mr. Emile Bachelet, late city electrician of Tacoma, Wash., has located in San Francisco.

Mr. Fred. T. Newberry, the well known civil engineer and inventor of Newberry's driven rail bond, has been elected president of the California Association of Civil Engineers.

Mr. B. C. Condit, late of the Central California Electric Company, and stationed at Newcastle, Cal., has gone to Japan in the interests of the Westinghouse Electric and Manufacturing Company.

Mining

ELECTRIC HOISTS IN MINING.

The application of the electric motor to hoisting work and the appreciation of such a combination by mine operators is shown by the numerous installations of electrical hoists which have been made in mines during the past few years. In the operation of these hoists it has been found that they emphasize to a marked extent the advantages of electrical operations. They may be located in relation to the incline or shaft exactly where they can be operated with the greatest advantage consistent with convenience or position, without any of the pipes inseparable from the air or the steam hoist. In responsiveness to the movement of the starting lever, the electric motor is instantaneous. There is no short interval of hesitation as in the steam hoist. The speed is constant and only the requisite power required to handle the load is consumed, while the general cost of operation is less than with compressed air or steam hoists.

These points in favor of the operation of hoists by electricity have been demonstrated in many instances,

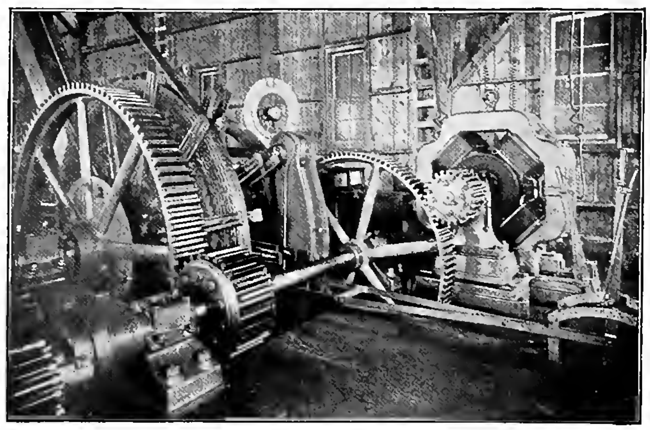


FIG. 1.—OVERBALANCED ELECTRIC HOIST. FREE SILVER MINE, ASPEN, COLO.

and the following may be looked upon as affording additional evidence. At the Free Silver Mine at Aspen, Colorado, is an electrical hoist, rated at 125 h. p., but capable of applying to the hoisting machinery power to the extent of 200 h. p. This is the largest electrical hoist in the world. It is a double reel flat rope over balanced hoist built after the designs of Mr. D. W. Brunton, manager of the Free Silver Mining Co., and also of the Cowenhoven tunnel, Della S., Alta Argent and Johnson Mines.

The electrical equipment consists of one General Electric Company's 100 kilowatt multipolar motor, with a speed of 550 revolutions per minute, and a smaller motor of similar type of 60 K. W. capacity and a speed of 475 revolutions. This smaller motor is ordinarily used to run an air compressor and winch for pulling pumps, but in case the main hoist-motor is called upon for heavier work than usual, the smaller one can be thrown in gear with it.

The hoist being counterbalanced, the load on the motors is reduced to about one-third of that which would be thrown on a plain hoist of the same capacity. The radius of the arms of the reels is 5 feet, each reel carrying 1500 feet of rope 4 inches wide and 3-8 inches thick. The hoist is provided with a car and cage, and the loaded car and cage weigh about 5000

lbs. As in sinking the mine it cannot be timbered entirely to the bottom, and the cage cannot go below the timbering, a bucket is hung below the cage. This is 35 inches high and about 28 inches in diameter. It weighs 400 lbs., and holds $12\frac{3}{4}$ cubic feet of water weighing 800 lbs., or rock weighing 2000 lbs. To relieve the shaft from a sudden inflow of water, this hoist is provided with a bailer, which is used as an adjunct to the pumps. This is 4 feet 2 inches by 3

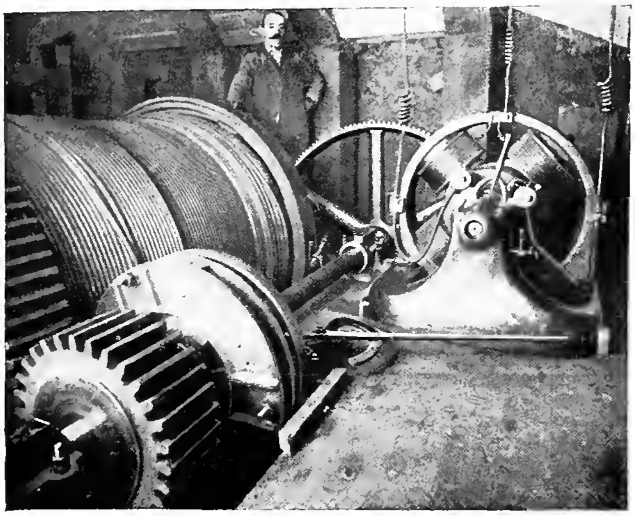


FIG. 2—ELECTRIC HOIST. ALTA ARGENT MINE, ASPEN, COLO.

feet 2 inches by 8 feet 4 inches and weighs empty 1,950 lbs., and filled 8,880 lbs. The counterweight used with the cage and bucket is 2,450 lbs., with the cage and car 2875 lbs. With the bailer these two weights are used making a total counterweight of 5,125 lbs. The maximum hoisting speed with the cage and ore, and using the small pinion on the motor, is about 600 feet per minute; with the bailer and using the larger pinion about 1,000 feet per minute. The pressure used in 525 volts, and the current is taken frem the central station at Aspen.

Last summer an interesting test was made with this hoist when using it for bailing. At that time the mine shaft was 835 feet deep, a depth to be ultimately increased to from 1,200 to 1,500 feet. The condensed figures showing the operation of this hoist during the test are as follows:

	Hoisting.	Lowering.
Weight of bailer and water	8,880 lbs.	1,950 lbs.
Weight of counterweight	5,125 lbs.	3.175 lbs.
(Ropes balance considering entire trip.)		
Net weight	3,755 lbs.	3.715 lbs.
Depth of shaft	835 ft.	835 ft.
Work performed	3,135.425 ft. lbs.	2,651,125 ft. lbs.
Time	2.25 min.	2.25 min.
Foot-pounds per minute	1,393,521	1,178,277
Mechanical horse power	42.2 h. p.	35.7 h. p.

At the Alta Argent Mine, also at Aspen, is another hoist which is placed at the head of the incline. The current is taken from the power plant of the Roaring Fork Electric Light and Power Co. $3\frac{1}{2}$ miles distant, two miles being above the ground and $1\frac{1}{2}$ miles through the Cowenhoven tunnel and mine workings. This hoist is also over balanced and is equipped with a General Electric Company's multipolar slow speed 500 volt motor, having a capacity of 20 h. p.

The location of the Alta hoist has been arranged with an eye almost exclusively directed to the convenience of handling the cars. The hoist is placed on a platform about 10 feet above the level at the head of the incline, where the ore cars are stopped and run off after being hoisted. Here the hoist operator stands and handles his controlling levers and reversing switch. This arrangement gets the hoist out of the way, while it allows the operator to attend to the cars. In the case of other hoists at Aspen, the hoist is placed directly at the head of the incline, which relegates the operator to the back of the hoist, where he can see both shaft and rope at all times. To attend to the cars he would be compelled to pass around the hoist, and as this entails loss of time, a second man to handle the cars is usually necessary. At the Alta Argent, one man suffices to operate the hoist and handle the cars.

In the mines of the Pleasant Valley Coal Company of Castle Gate, Utah, is another direct current mine hoist used for hauling the coal cars up the incline. This hoist is a Lidgerwood double reduction single drum hoist, equipped with a standard L. W. P. 20 h. p. railway motor and double 51 rheostat. It is designed to lift 4,000 lbs. 500 feet per minute. The drum is 47 inches in diameter and 36 inches face with two brake bands in V shaped grooves on the drums. It is provided with both friction and positive clutches, and is operated by five levers—one for the rheostat, one for the friction clutches, one for the positive clutch and two for the brake. The dimensions of the base on which are mounted the drum, motor and controller, are only 78 inches by 95 inches. Another hoist of similar pattern but using a friction clutch only and a G. E. 2,000 motor with a double 83 rheostat, has recently been added to the very complete mining equipment of the Pleasant Valley Coal Co. The motor in this case is fully enclosed.

The three hoists just mentioned are in the West. In the mines of the Lehigh Valley Coal Company at

FIG. 3.—HEAD OF INCLINE, ALTA ARGENT MINE. HOIST CONTROLLED FROM THIS POINT.

Maltby, is the direct current electric hoist shown in the illustration, very similar to that at the Castle Gate Colliery. The dimensions of the drum are the same, the G. E. motor is of similar capacity, but the controller is of the N. R. type with packed ribbon rheostats mounted separately from the base. It is designed to hoist 5,000 lbs. at a speed of 500 feet per minute.

All these hoists are and have been in constant service for months without serious hitch or stoppage be-

yond those necessitated in ordinary mine service. They have been found superior to steam hoisting engines, both in efficiency, in simplicity, in convenience, and in speed of operation, and no better proof can be adduced than that in the three first mentioned cases, the first hoists have induced orders for additional ones.

The General Electric Company has also placed several installations in mines for the kindred purpose of haulage. The Woodward mine of the Delaware, Lackawanna and Western R. R. at Kingston, Pa., for instance is about to be equipped with electric haulage by the General Electric Company. In this, the generating plant will consist of one 165 k. w. dynamo directly connected to an American Ball engine. The circuits will be three in number. The first will pass down a vertical shaft 725 feet deep and will operate one-ten ton locomotive in the Cooper vein. The two others will be carried down another vertical shaft 1026 feet deep to operate two, ten-ton locomotives in the Red Ash and Baltimore veins. These locomotives will be equipped with two 40 h. p. G. E. motors, and will handle trips of loaded mine cars each loaded car weighing about four and one-half tons. It is estimated that this installation will show in operation a net saving of 29.5 per cent over mule haulage, including a large reserve for depreciation, interest and fixed charges. The total output of these three locomotives will be about 3,800 tons per day, and the total length of trolley wire in the gangway will shortly reach four and a half miles.

FIG. 4.—ELECTRIC HOIST IN MALTBY COLLIERY, LEHIGH VALLEY COAL COMPANY, WILKESBARRE, PA.

Obituary

CHARLES E. LIVERMORE.

Charles E. Livermore, died in Oakland, Cal., on March 7th last from heart failure. He was nearly sixty-three years of age and has always resided with his brother, H. P. Livermore, at Rock Ridge Park, back of Oakland. He was one of the oldest citizens of the State and was interested in many institutions and companies in San Francisco and the State at large.

The deceased was born in Boston, April 2, 1834, where he received an education in the public schools. Entering business life, he passed three years in the service of a prominent wholesale drug firm of Boston. He came to San Francisco in 1857, where he entered the employ of the firm of wholesale druggists, Redington & Co. He brought with him from Boston an ardent love of athletic sports, and speedily after his arrival was instrumental in organizing the first rowing club on California waters, and later became one of the fourteen original incorporators of the Olympic Club of San Francisco.

When the development of the Comstock vein in Nevada took place he established a wholesale drug and chemical house at Virginia City, doing a large and successful business there for many years. When the decline of Virginia City commenced he closed out his interest in this business and returning to San Francisco became interested in the Redington quicksilver mine of Lake county in connection with the late John H. Redington and his brother, Horatio P. Livermore. When this mine was sold he became interested with his brother, H. P. Livermore, and other prominent associates in the development of the water power of the American river at Folsom, and this work and the kindred enterprises which have grown out of it engrossed all his time and faculties up to a brief period before his decease.

CHARLES E. LIVERMORE.

Although not educated as such, Mr. Livermore had great natural capacity as an engineer and inventor, as well as a remarkable artistic talent. This was his special province in the great works upon which he spent the last years of his life, the financial and business details being under the direction of his brother, H. P. Livermore. As President of the Folsom Water Power Company he directed the engineering plans which have resulted in the water power which, from the American river at Folsom, has done so much to recreate Sacramento city.

Mr. Livermore was an original member of the San Francisco Art Association and always devoted to its interests. He never married, but made his home in the family of his brother, H. P. Livermore.

His extensive interests in the various corporations to whose development he devoted himself are understood to be bequeathed by him to his nephew, Norman B. Livermore, who will succeed to the positions connected with the various companies lately occupied by his deceased uncle.

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EDITORIAL.

THE BARRIER TO HIGH VOLTAGES.

Let the truth be known that in the present state of the art, electric transmissions of power do not find limitations in difficulties attending the generation or transformation of high voltages as is commonly understood. The step-up transformer will reliably deliver not only 10,000 or 20,000 volts, but 60,000, 70,000—80,000, or if desired, even 100,000 volts or more, and the step-down transformer will satisfactorily reduce these potentials to such as may be put to any desired purpose. When man has used these voltages and aspires to yet higher potentials that the cost of copper may be further reduced, undoubtedly he will have so advanced in technical knowledge that the transformer will stand true and faithfully give him practically any voltage he seeks.

Not to that most trustworthy servant, the transformer, then, may the present limitations of electric transmissions be ascribed, but the appliance that now bars the way to the use of higher voltages is the insulator. Lightning, static discharges and grounds will probably constitute troubles that will always beset aerial lines to a greater or less extent. When the perfect insulator has been devised, the overcoming, or rather the alleviating of grounding troubles will find its best ally in thoroughness of mechanical construction, but the trusty transformer alone presents the hardihood to defiantly refuse and withhold admission to lightning and its attendant effects. Generators are inclined to flirt with the "forked flash," though they extend no encouragement to static discharges, but the flirtation is generally manifested only in a flutter of the needle or the flicker of the lights. Science has well in hand the control of lightning, of static effects and of the mechanical features that give permanance, safety and reliability to overhead transmission lines, nor is difficulty experienced in the handling of line voltages at present used, but the barrier—thus far insuperable—to the employment of higher potentials is, as stated, embodied in the insulator alone.

Climate exerts a potent influence on the reliability of insulators and so great is this influence that to it rather than to the insulator itself may be attributed the existing limitations to the commercial use of higher voltages. In addition to being a practically perfect non-conductor, the insulator should be wind, rain, snow, sleet, dust and insect proof. Its reliability as a sure preventive against all possible sources of trouble should be absolute, for, if susceptible to breakdowns, its weakness necessitates the duplication of the transmission lines that no interruption to service may occur in making repairs. The saving in copper which will result from the invention of a perfect insulator would be two-fold in that it would enable the use of higher voltages and require only a single transmission line. Truly may it be said that unlimited reward awaits the inventor of a perfect high tension insulator.

It seems that nowhere are conditions so favorable for the use of highest voltages as in California, for here, with abundant though distant water powers, with unlimited though undeveloped resources, with power a very high priced commodity, and with an electrically perfect climate, lòng distance transmission of electric power will continue to find its most favored field.

TRUSTS DECLARED ILLEGAL.

It is time for most serious reflection when the highest tribunal in the land hand down its decision that trusts or pools or any manner of combinations of capital to influence or fix rates or prices of any commodity, is unlawful. Such is the substance of the finding in the now famous Trans-Missouri case. In it the Court held, among other things, that (1) the Sherman act includes all trusts of whatever kind; (2) no special exemption exists in any other law for the existence of pools or trusts of any kind; (3) trusts are aggregations of pools or associations of committees of boards of capital or the representatives of capital formed or maintained for the purpose of fixing rates or prices; (4) the sole purpose of all these combinations of capital is to get more than a legitimate amount of money out of their customers; competition is a necessity of legitimate trade, hence combinations to obstruct free competition are unlawful and against the letter and the spirit of the Sherman act.

Hardly an industry in all the fabric of American commerce will be exempt from the effects of this most far-reaching decision and while it strikes at the vitals of existing corporate methods, and while it will possibly necessitate their reorganization, the public will doubtless feel gratification in the knowledge that the Supreme Court of the United States is invulnerable to the influences even of the combined capital of the country. The decision will be looked upon as a tri-

umph of justice and a fitting recognition of the people's protest against the all-consuming avarice of corporate wealth.

The monopolist who finds solace in the paraphrase, "Competition is the thief of dividends," will realize but chilling consolation in this emphatic upholding of the law abolishing pools, trusts, combines and compacts. He will lay the odium of it at the door of the masses whose weapon struck such a telling blow for Bryanism last November, and his first action will probably be the reduction of wages in consequence of reduced profits, for he will argue, as trusts are abolished, profits will vanish and we must economize. This follows as a natural consequence, of course, but labor, stalwart as it is, would stagger at the shock of a voluntary raise in wages because of the formation of a trust and the prospect that profits would be increased thereby. Poor labor, the cat's paw of politicians, the scapegoat of capitalists!

The immediate results of the decision will be manifested in anxiety as to the present and speculation as to the future. But while the thoughts of the many flow in this channel, those of the few are forcing themselves through every fissure and seam of possibility in quest of an egress to the unchecked open of evasion. Will they find it? Probably rather than possibly, but in any event the unqualified condemnation of trusts by the highest tribunal in the land will prove a wholesome deterrent to the unrestricted throttling of competition. In the electrical industry, the wire association, the lamp combine and the patent pool of the General Electric and Westinghouse Companies—which is of wider significance than the mere exchange of patent privileges—must be terminated. It will doubtless transpire that such terminations will prove ostensible rather than real, in which event unlawfulness will find its most effectual mark in secrecy.

Can it be that this decision will force the consolidation of the principal corporations of each industry into a single concern far more formidable than any trust? In rejoicing over the triumph of the Trans-Missouri decision the masses should not forget that the atmosphere of unification of interests pervades the corporate world.

INTERIOR CONDUIT METHODS.

Both interesting and opportune are the discussions that have been opened by the efforts of the Underwriters' National Electric Association and the National Conference on Standard Electrical Rules, to formulate a single standard for safe wiring, but none have received greater attention than the question as to whether plain iron pipes or insulating-lined iron pipes are the more suitable for interior conduit construction. The Electrical World, realizing that the cost of interior conduits is one of the largest items in electrical construction, evidently desires to be fully informed before committing itself to an endorsement of the method which will permit the greatest economy consistent with safety, and accordingly, in executing its laudable resolution, it has obtained expressions of opinions on the subject from many interested engineers and manufacturers.

As might be expected, the views presented are widely diversified, some advocating absolutely bare pipes to be used with the best quality of insulated wire, while others favor an insulated tube as offering an additional safeguard. Nevertheless, each opinion presented brings out points of moment although it is evident that all the views are not those of the specialist of broad experience. The wire manufacturer who contends, for instance, that the proper method to use is one which will confine any arcing within the pipe, as he intimates will be done "by having the various pipes of a conduit system thoroughly connected together," advocates a mode that will unquestionably protect the building so wired, but how about the buildings next door or in the next block, and all of those that are lighted from the same circuit and which are endangered by a grounding occurring anywhere on the circuit? Nor can the blowing of fuses be relied upon as showing a difficulty, for the most potent dangers besetting the use of electricity are the insinuating, pernicious and persistent leaks that slowly but surely disrupt the circuit without affecting the fuse in any way. Indeed the expression, "safety fuse," is a misnomer—a legacy of those early days when the overheating of a wire was believed to constitute the chief danger attending the use of electric circuits. It is surprising that at this late day its real sphere of usefulness should be unappreciated.

The subject of conduit construction is so limitless and the conditions of installation are so varied that no one should wonder at the conflicting opinions expressed, but none of the suggestions thus far published are unworthy of serious consideration. When Mr. Brooks, of the American Circular Loom Company, writes: "I am last and always in the interests of an insulated raceway having no joints or molded elbows," he voices an honest opinion founded on an intimate knowledge of the insuperable difficulties that eventually arise in conduit systems wherever and whenever the details of installation have been entrusted to the hands of indifferent or unwatched labor. It is a sad commentary on the fidelity of labor that unwatched it is too often not to be depended upon, but the world of employers admits this truth, at least to itself. So it is that in the flexible conduit system which Mr. Brooks has developed is seen a well matured effort to eliminate from conduit construction to the fullest possible degree, the venturesome, if not uncertain factor of fidelity and thoroughness in labor.

So too, and probably above all others, must one weigh the words of Mr. E. H. Johnson, the father of interior conduits, and give heed when he emphatically condemns any method other than an insulating-lined

conduit, the insulation resistance of the lining being depended upon as an additional safeguard beyond the usual resistance of the wire. Mr. H. Ward Leonard advocates "A plain iron pipe system with the two poles of the circuit in it;" Mr. E. R. Knowles writes that "nothing is gained by having an insulating-lined tube;" Mr. Geo. A. Hamilton insists that "the insulation of the wire is the prime requisite," and Mr. J. W. Marsh, of the Standard Underground Cable Company, in expressing the same belief, suggests that a thin coating of enamel would be sufficient to prevent oxidation of the conduit or abrasion of the insulation. And thus, in brief, do the ideas run, the consensus of opinion thus far expressed favoring the use of iron pipe without insulating lining other than enamel, asphaltic paint or other substance giving a smooth surface and which will prevent oxidation. Indeed, Mr. Leonard seems to have struck the keynote of the opinions given when he states that "the perfect conduit would be a strong metal pipe, lined with a smooth incombustible, highly insulating, but thin wall of material which could not be affected by any chemicals."

To the writer it seems that the tendency is to add an avoidable confusion to the matter by failing to discern the true cause of the only difficulties that appear insuperable—namely, condensation and its resultant effects. With a continuously smooth and well powdered interior surface, the liability of abrasion may be dismissed; to prevent oxidation it is only necessary to seal the conduit as one would a steam pipe so as to prevent the entrance and circulation of air with consequent condensation; then abstract the moisture from the air within the conduit by chemical or other equally simple means.

No difficulty is encountered in piping a building for gas, water, steam or even compressed air, the hardest to confine of all, and the engineer who would hesitate to design and install a system of interior conduits which would not only absolutely prevent the circulation of air, and the condensation of moisture therein, but would also be provided with means for abstracting the moisture from the air already contained, must have an exaggerated idea of the difficulties encountered, or be faint-hearted indeed. It may be necessary to use an air pump, but does not the gas inspector do the same? The wires at outlets must be sealed air tight and yet be easy of removal, but is not a stuffing box a simple, effective, cheap and ever ready appliance? Joints and stuffing boxes must be sufficiently tight to prevent the mingling or the osmose of the internal and external atmospheres, but are they not so in gas piping? Experience in this direction may prove it advantageous to fill the entire system of piping with an inert gas such as nitrogen (than which air alone is cheaper), from which all moisture has been abstracted. When this is all done, air has been excluded and a harmless inert gas alone fills the tube, thus preventing oxidation, and moisture is excluded from the tube, thus preventing dampness, the fore-runner of oxidation, as well as the seed of that which is at once prolific of those diseases so fatally affecting insulations.

It will be said: "that scheme will never work because of the difficulty attending the withdrawal of wires and the inserting of new ones." To remove a wire from a tube will present no greater difficulty than renewing the glass tube of a water gauge in a steam boiler, and after the wire has been replaced and the conduit again closed, it could be filled with nitrogen compressed in a portable accumulator as readily as could a bicycle tire be filled with air. Moreover, can any one cite a circuit trouble which ever occurred in iron armoured conduit work that was not due directly or indirectly to abrasion, to moisture or oxidation or dry rot, and these are diseases that are positively preventable by the construction outlined.

In brief, the promoters of the new art of interior conduit wiring must look to the old trades of long experience for mechanical wrinkles that, overlooked, may prove their undoing. Electrical engineers are prone to underestimate the necessity for perfecting mechanical considerations by yielding to preferences which lead them to attribute defects of whatever nature to electrical causes. The causes of conduit troubles are, first, abrasion; second, moisture; third, and last, oxygen;—all being difficulties readily overcome by mechanical means.

The remedy proposed seems radical, but should the reader care to test his own impressions of it, submit it, not to the party who manufactures interior wireways, nor to an electrical engineer whose opinions may be blunted or even perverted by personal interests, but to the honest contractor who has had the broadest experience in conduit construction, who has no goods to sell and who may best give a frank and unbiased opinion on its merits.

THE TROLLEY TRIUMPHANT.

Americans have been constantly reminded of their barbarity in permitting the use of the overhead trolley, and have been told of the greater civilization of the countries of the old world, where no such unsightly intrusion is permitted; but the trolley now seems to be making its inroads in France and Germany with remarkable rapidity. Even in Paris overhead wires are being talked of for the transportation facilities of the coming Exposition of 1900, and in the provincial cities of France, as well as in the great majority of the cities of Germany, the American system seems to have gained a firm hold. That the overhead wire is unsightly is not to be denied, and ultimately, no doubt, it will have to give way to some less objectionable form of power communication; but that it is a necessary intermediate stage of the solution of the rapid transit question, must be admitted, whether the admission be welcome or not.—Cassier's Magazine.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

"THE CATECHISM OF ELECTRICITY," by N. Hawkins, M. E. 341 pp, 295 illustrations, Pocket-book form, bound in red leather with gilt edges. Published by Theo. Audel & Co., 65 Fifth Avenue, New York City, 1897. Price $2.00.

The electrical engineer who has won fame probably through the pursuit of some special branch of his chosen profession, is frequently asked to recommend a book that will tell "all about electricity in simple language." The reply usually takes the form of the oft-told dissertation on the infinite broadness of the applications of electricity; that books of merit rarely treat of more than one branch of the subject; that for one person to know "all about" electricity is physically impossible; that this is a day of specialists and that, as the enquirer seems determined to learn something about the science he had better first decide on the line of the business he wishes to follow—whether it is to be illumination, transmission, transportation or communication—and then it will become possible to advise the course of books to read. Rarely does this reply satisfy the beginner who fancies that if he does not know he may easily learn "all about" electricity—if he only had the right kind of a book. There's the rub, or rather, there was the rub, for rub it was no longer since the publication of "Hawkins' New Catechism of Electricity," and now that this book has appeared one need not longer hesitate to recommend it as the one eminently adapted to satisfy the wants of those who know nothing of the science, yet are possessed of an unmoulded desire to become electricians. It will give the learner no false ideas, it will show him that there is more to the electrical business than his immature mind had ever conceived, and it will not only put him on the "right track," but its practical teachings will tend to keep him there.

The preface points out very properly that "this work is addressed not to the experimenter or to the toy maker, nor to the scholar in school or college, but to those who have to deal with electricity as part of their life's work." It appears to the reviewer that the preface should have placed more emphasis on the educational and practical features of the book. It is distinctly educational in its definitions of electrical words, terms and phrases, and is, at the same time, practical in its directions for the care and management of dynamo electric machinery and of engines and in the completeness of its circuit diagrams. The mode of treatment will make the book doubly acceptable by the class for which it has been written and the practical man of every clime will endorse the spirit which pervades the work as expressed in its introductory remark that "Electricity and gravity are as subtle as they are mighty; they elude the eye and hand of the most skillful philosopher. In view of this it is well for the average man not to try to fathom too deeply, the science of ether; neither Edison nor Tesla have done that yet."

Viewed from a typographical standpoint, it will be said that the book suffers from indifferent proof reading and that it presents a "padded" appearance. Handbooks of this character are ordinarily supposed to be brim-full of information—in fact to be crammed with it to the utmost, yet here is seen all matter double leaded; extravagant display lines appear prominently as, for instance, the applications for which storage batteries may be used are strung out so as to cover half a page as is the custom in hand bill advertisements. Then the reproduction of the insurance code for wiring consumes 43 pages, while one-quarter of that space would have sufficed. It is true that light, airy looking pages such as these certainly are will appear at once more inviting and less formidable, still the electrical engineer will be apt to overlook this and feel that the endeavor has been to "fill up" pages. But, after all, the book was not written for the electrical engineer or the college professor; instead, it was written for the steam engineer, the line man, the dynamo or switchboard attendant, the armature winder and, in brief, for the electrical artisan, as well as for the general reader and the man who "wants to know all about electricity." As such it serves its purpose most commendably.

Pneumatics

COMPRESSED AIR IN SHOP PRACTICES.

John J. Flather, Professor of Mechanical Engineering of Purdue University, during a discussion of a paper on "Some of the uses and advantages of Compressed Air," which was read by Mr. J. H. McConnell at a recent meeting of the Western Railway Club, brought out an interesting comparison between the efficiency of compressed air and electric transmission. After pointing out the prevalent methods adopted for reducing the losses due to line shafting by installing independent motors, Prof. Flather recited noteworthy instances of the successful use of compressed air and stated that in the compression of air with steam actuated compressors, there are various sources of loss which in the aggregate will vary from 25 to 45 per cent of the total power of the machine. The principal loss is usually that due to heating the air during compression. If the air is not cooled during compression by some external means, the compression curve will be adiabatic; on the other hand, if the temperature of the air be kept constant the curve will be isothermal; in the first case, a certain amount of useless work will be done in heating the air, which necessarily becomes cooled during transmission, so that while the pressure remains practically the same, the volume will be reduced. This loss becomes greater as the pressure increases. If, however, the air be carefully cooled during compression the loss will be diminished. In tests made by Prof. Reidler on two-stage compressors in which the air was passed through an intermediate cooler before final compression, the loss, due to heating, under a gage pressure of 75 lbs., was only 11 per cent—an exceptionally small value, 15 per cent is nearer average good practice, and 30 per cent is not uncommon. In addition to this heat loss there is the friction loss of the compressor which varies from 12 to 20 per cent and even more than this in some of the older inefficient machines. The other sources of loss are those due to heating the air previous to and during its admission into the compressor; insufficient air supply, and losses due to clearance and leaks. The free air which enters the compressor should be drawn from outside the engine room where the air is cool; in the same way, contact with hot surfaces during inlet should be avoided. An increase from 60 to 100 deg. F.,

means a loss of 7 per cent in the volume of air delivered. Ordinarily this need not be large and may be taken at 4 per cent. Taking the efficiencies corresponding to the above, we have for the average efficiency of a good air compressor working under constant load at a gage pressure of 70 to 85 pounds, about 65 per cent. In the transmission of air, within reasonable limits, the loss in transmissión need not be considered. The velocity of flow of air is entirely different from that of water—its friction resistance being less than 1 per cent of that of water.

The greatest loss of efficiency is that in the motors. It is impracticable to re-heat the air with any degree of economy when employed intermittently and we find almost without exception, that the air is used at normal temperature for the various purposes to which it is applied in and about railroad and other shops. Experiments by Professor Riedler, and others, with small air motors (1 h. p.), in which the air was not re-heated, show the loss in the motor to be about 65 per cent when the air is used without expansion. With better designed motors and air expanded from 68 deg. F. down to 54 deg. F. the loss with a 2 h. p. motor was only 33 per cent. By re-heating the air to 140 deg. F. and expanding down to 28 deg. F. the loss was 25 per cent. With a larger motor, which was a made over steam engine of 80 h. p. the air at a pressure of 79 lbs. was heated to 300 deg. F. and expanded to 90 deg. F. with a resulting efficiency of 81 per cent. In this case the cylinder was jacketed with the hot air, which accounts in part for the relatively high efficiency. These results and others would indicate that compressed air as now used is not at all efficient as a source of motive power since the combined efficiency of compressor and motor at constant load even under favorable conditions, is not more than 50 per cent of the available energy put in the compressor. In other cases the efficiency is as low as 20 per cent.

In regard to the cost of the power thus obtained from compressed air, in the small inefficient motors, tested by Reidler, the air consumption was about 1,600 cubic feet per brake horse power per hour; but in the larger motor when developing 72 h. p. the air used was somewhat less than 500 cubic feet per brake horse power per hour. Assuming 5 lbs. of coal per horse power hour and its cost $3 per ton, the fuel cost of producing the air will be about 3 cents per 1,000 cubic feet, so that in the first case the power cost as determined by fuel consumption amounts to nearly 5 cents per horse power hour; and in the second case the cost is about 1½ cents per horse power hour.

There should be no comparison between the cost of transmission of power by compressed air and electricity, since each has its own field of usefulness; yet it may be interesting to note, for our present purposes, the efficiency of electric transmission. A modern generator belted from an engine will have an efficiency of about 90 per cent when working under favorable conditions, but as the average load is ordinarily not more than two-thirds full load, and often much less, the efficiency will not usually be more than 85 per cent. Since the engine friction was added to the losses in compression so also it should be considered here, in which case the efficiency of generation will be between 75 and 80 per cent.

The loss in transmission need not be more than 5 per cent, so that the efficiency at the motor terminals will not be far from 75 per cent. With motors running under a nearly constant full load the efficiency of the motor may be 90 per cent; but with fluctuating loads this may fall to 60 per cent at quarter load. When the driven machines are not greatly over-motored we may assume a motor efficiency of 80 per cent, which may be less or greater in individual cases. The combined efficiency, then, of generator and motor working intermittently with fluctuating loads, will be about 75x80, or 60 per cent of the power delivered to the engine.

In work of this kind it is well to remember that while the efficiency may be very high the economy may be very low, and good engineering is primarily a question of good economy, all things considered. It is not the most efficient plant which produces the greatest economy. While it is interesting to know that a certain amount of power may be transmitted a given distance with a high efficiency, it is more important to know that the same amount of power could be obtained at the objective point for one-fourth the cost of the former. Both compressed air and electric motive powers possess the advantage of using energy only when the motors or other apparatus are in operation, but in addition, compressed air possesses so many other advantages that however inefficient it may be as a motive power we shall expect its application to shop processes to be continually extended as its usefulness becomes better known.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

A CIRCUIT BREAKER FOR SMALLER CURRENTS

The well known automatic circuit breaker of the General Electric Company, known as form K, for heavy currents, is now followed by one for use with smaller currents, i. e., for 100 to 500 amperes. It is known as the form L and as with the K, may be used on any potential up to 750 volts.

The deleterious effect of arcs on unprotected contact parts destroys in a short time their usefulness, introducing a serious problem on all circuit breaking apparatus, and the greater the voltage and current the greater the difficulty presented in handling arcs. To eliminate the destructive effect of arcs on contacts the magnetic blow out principle was applied, and by this a means is provided for destroying the arc at the moment of its formation. The addition to a switch thus equipped of a tripping device to open the circuit as soon as a predetermined current flows, gives an automatic circuit breaker unsurpassed for reliability and convenience.

The form L circuit breaker is substantial in construction and compact in form. It is mounted on a slate base 11 in. by 12½ in., and the maximum overall measurement from the back of the base is 6 in. It can be provided with either front or back connections. Its action is similar to that of the (Form K) circuit breaker, adopted so widely in power stations for use with heavy currents. The current passes through built-up leaf contacts to the tripping coil, the armature of which actuates the tripping device. An adjustable tension spring holds the armature away until sufficient current flows to overcome its pull, drawing the armature to the magnet coil.

The leaf contacts are held normally against the main contact blocks. When the tripping armature is drawn to its magnet, the main contact is released and the circuit instantly opened by the action of the main spring. To prevent arcing at the main contact, the current is shunted through a secondary contact plug protected by the blow-out magnet. This plug is not withdrawn until after the leaf contacts have left the contact blocks and all tendency to arc, therefore, is confined to this point, where the magnetic action prevents it from doing damage. The blow-out magnet and secondary contact are in series with each other, but are connected in multiple with the main contact. Owing to their high resistance practically no current flows through them until the circuit through the main contact is opened, when they take the whole current, creating the magnetic field and extinguishing the arc independently and apart from the main contact.

The marked rating of a circuit breaker, as 100-500, indicates the lowest current that will automatically open the circuit and the maximum normal current carrying capacity. The circuit breaker is set to open at any desired current from its lowest rating to 50 per cent in excess of its highest rating, by adjusting the calibrating spring of the tripping armature. An indicator on the adjusting stud registers with well spaced marks on a brass scale, showing the current at which the circuit will be opened.

The handle of the Form L circuit breaker is removable, but is automatically locked in place so long as the circuit remains closed. It can be removed only when the circuit breaker is open. Moreover, when the handle is removed the circuit breaker cannot be closed. This interlocking device allows feeder circuits to be kept open at the will of a single operator, avoiding to a large extent any accidental closing.

Although automatic in action and capable of carrying safely the currents within their rating, and of opening the circuits on heavy overloads and short circuits, circuit breakers should be given a reasonable amount of care and attention to insure satisfaction with continued use. By regarding this injunction the life will be very much prolonged.

NEW BROOKS-FOLLIS AGENCIES.

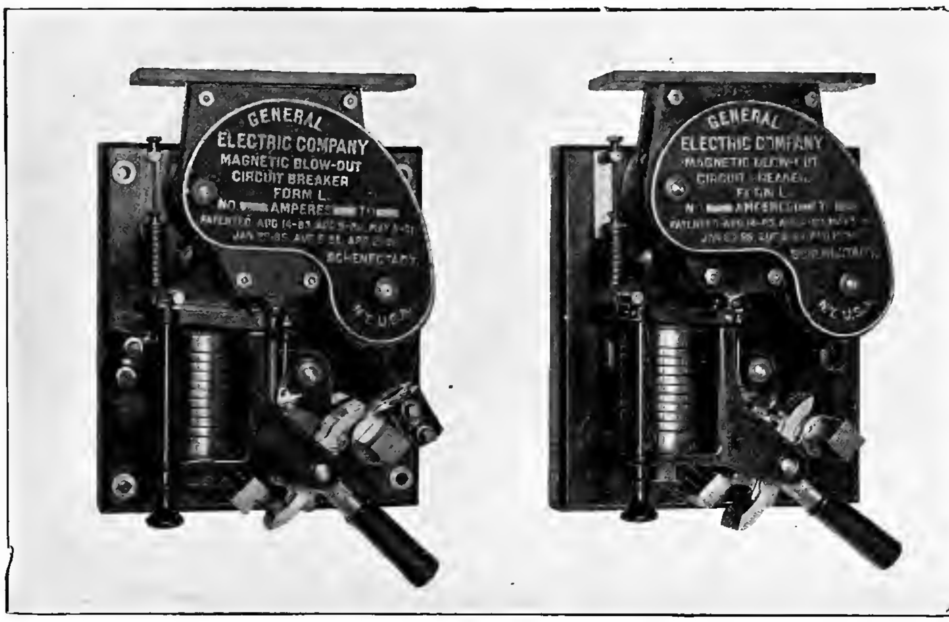
The Brooks-Follis Electric Co. has taken the exclusive Pacific Coast Agency for the Lundell Power and Fan Motors, manufactured by the Interior Conduit and Insulation Co., of New York, and up to the present time has met with great success with sales.

As a starter, it has sold to the Pacific Electric Motor Co., of San Francisco, one hundred and fifty motors, ranging from $\frac{1}{4}$ to 2 h. p. in capacity each, and has also received an order since then for twenty-six more motors. It has also sold the Pacific Power Co., of San Francisco, one Lundell Motor, one h. p., 500 volts; to John Bruener of Sacramento, one Lundell Motor, 2 h. p., 500 volts; to the Union Iron Works of San Francisco, one Lundell Motor, 5 h. p., 230 volts; to A. E. Brooke-Ridley of San Francisco, six $\frac{1}{4}$ h. p., and one $\frac{1}{2}$ h. p. Lundell Motors, 110 volts, and to the Pacific Telephone and Telegraph Co., of San Francisco, three $\frac{1}{4}$ h. p. and one $\frac{1}{2}$ h. p. Motors. The Brooks-Follis Electric Co. is carrying a large stock of motors and is prepared to ship promptly.

The company has also just taken the agency for the Ideal Electric Corporation of New York, manufacturers of an alternating and direct long burning arc lamp, and the La Roche alternator. The alternating long life arc lamp, burning on 110 volts is meeting with great success, as this is practically the only long burning arc lamp for alternating current that is giving any satisfaction.

The Brooks-Follis Electric Co. is doing quite a rushing business in Lundell Fan Motors. A cut of this Desk Fan and also of the Ceiling Fan will be found on page 36. The Desk Fan Motors are superbly finished in rich japanning with gilt striping. They have a starting and regulating switch giving three speeds. On the 1-12 h. p. Fan Motor, the speed is 1800, 1400 and 1100 revolutions per minute. On the 1-6 h. p. Fan Motor, with a 16 inch fan the speed is 1500, 1200 and 800 revolutions per minute.

They are self-oiling and have self-aligning bases, and all outside base fittings are polished or nickel plated.



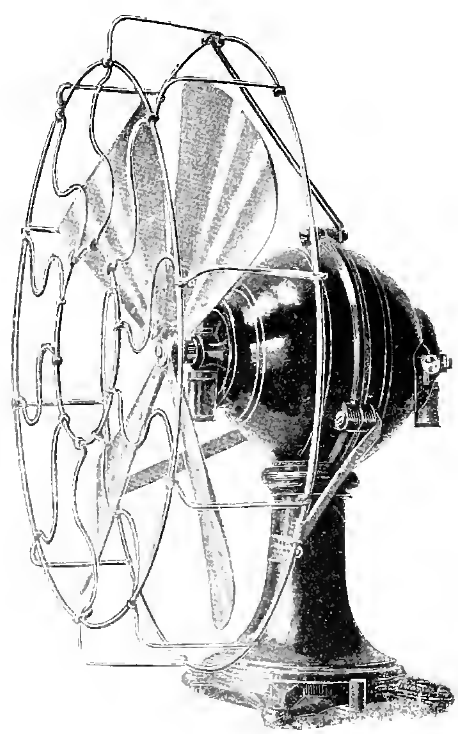
A CIRCUIT BREAKER FOR SMALLER CURRENTS.

The Ceiling Fans are handsomely finished with polished brass or nickel plate, with a highly polished wooden sweep. They operate at 150 revolutions per minute. The blades of the sweep are 68 inches and have a width of 8½ inches. One of the great talking points of their Fan Motors is the low consumption of current, the 12 inch Desk Fan consuming only .45 of an ampere, and the 16 inch Desk Fan consuming only .9 of an ampere, while the Ceiling Fan consumes only .9 of an ampere operating at 110 volts.

CEILING FAN.

These motors are built for all currents, alternating and direct, and a large stock is carried, insuring prompt shipment. The Brooks-Follis people have agents all over the country and are meeting with remarkable success in their sales. Messrs. Holbrook, Merrill & Stetson of Sacramento, who are their agents there, have sold over one hundred and twenty-five motors in Sacramento alone.

There have been some very low prices quoted on bushings and insulators lately, but the Brooks-Follis Electric Co. seems to be in a position to outclass them all, both as to quality of material and price. For instance: It is making a special price of $5.00 per M. on 5-16 Vitrified Clay Bushings. The bushing is well vitrified and very straight, making a perfect insulation, and desirable in all respects. A complete price list will be furnished upon application. Main line and branch block porcelain rosettes, ceiling cut-outs, white porcelain cleats, Edison and T. H. sockets are also being sold at remarkably low prices.



DESK FAN.

It would pay anybody intending to buy electric lighting material to investigate the Brooks-Follis prices, as they believe in doing business on small profits but making quick sales.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Flec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

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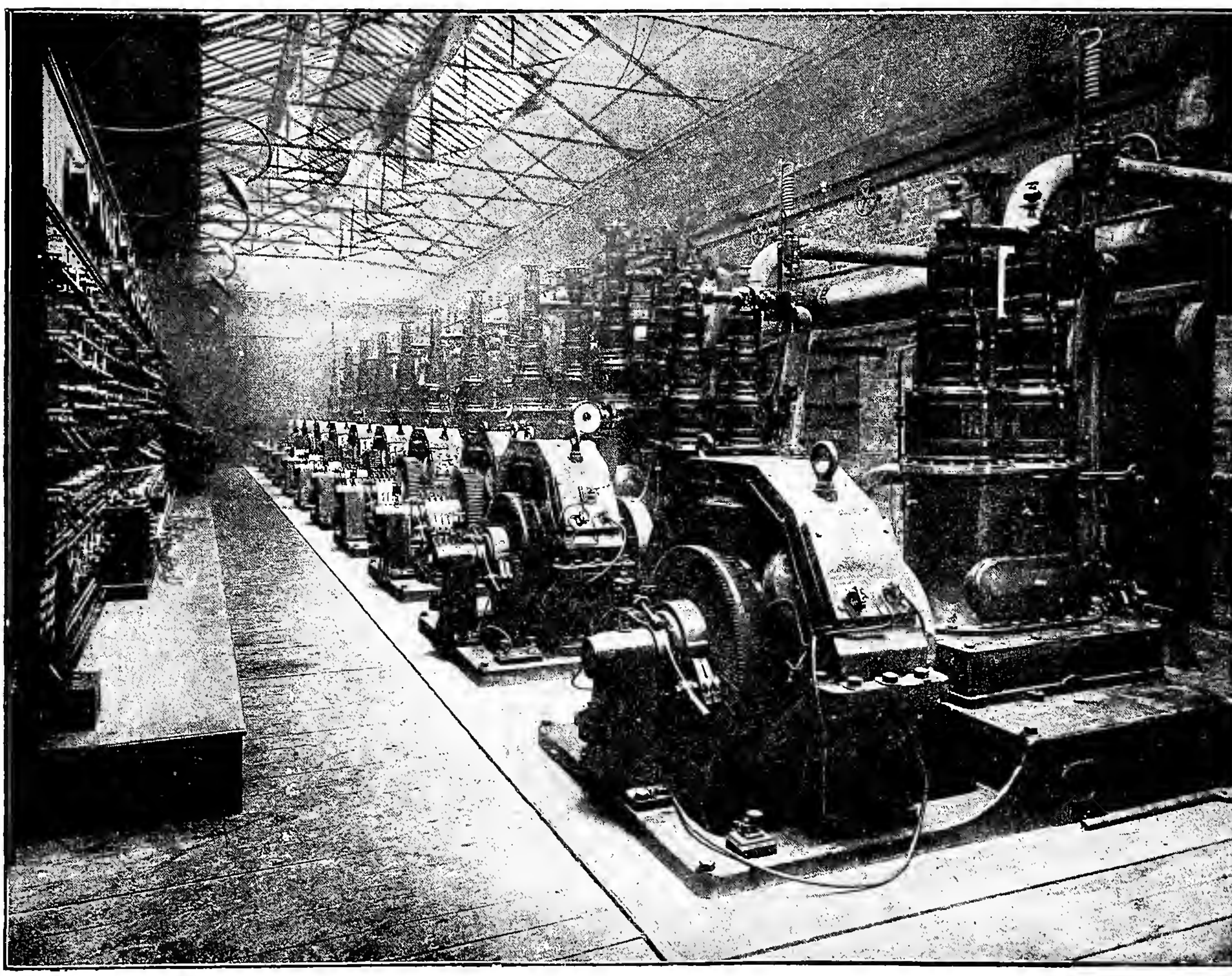
The Pacific Power Plant.

The Pacific Power Company owns nearly the entire block bounded by First, Mission, Stevenson and Ecker streets, in San Francisco, as well as most of the buildings thereon, and as these structures are well in the midst of the manufacturing district, it was desirable that the premises should be rented with power. It was thus that the Pacific Power Company found a reason for its organization, and from a modest neuclus it has grown quietly and but little known until now it is furnishing power to many blocks in its vicinity, and is, moreover, one of the most substantial corporations in San Francisco.



ST. PANCRAS VESTRY, REGENTS PARK STATION, LONDON.

Electricity was indeed "in its infancy" when the Pacific Power Company first undertook its use as an agent for distributing power over districts too remote to be reached economically by the lines of countershafting that it had extended underground throughout its own block and those immediately adjoining. The first apparatus installed was designed and made by Dr. N. S. Keith, who was then of San Francisco, who was founder of the American Institute of Electrical Engineers and who has recently achieved considerable new fame in England by reason of new processes he has developed for the reduction of refractory ores. This pioneer installation consisted of four 40 horse power horizontal field, bipolar dynamos, with armatures parallelling the axes of the fields. These machines were of a simple shunt wound, constant current type, having an output of approximately 15 amperes. The field was regulated by cutting 100 volt incandescent lamps in or out of

the field circuit and the constant attention of a switchboard attendant was required to keep the amperage at, or rather near normal, for, with the plain series motors used, the throwing off of five or ten horse power by a consumer, worked the ammeter needle into a terrified frenzy. Housetop distribution was used, with "undertakers' " wire, and while in the light of present knowledge the plant was woefully primitive and its efficiencies had perhaps better not be discussed, nevertheless it gave satisfactory service for nearly a decade. In 1894 the venerable old plant was relegated to the scrap pile and an underground system was installed under the specifications and supervision of Messrs. Low & Sprout, electrical engineers, whose business is now carried on by Mr. Sidney Sprout.

The new system of the Pacific Power Company consisted of a 113 kilowatt, 500 volt, Westinghouse multipolar generator of the then latest type, together with a distributing system embracing about twenty business blocks and containing over two miles of underground conductors. All conduits were of wrought iron pipe, all manholes were of brick laid with cement, with cast iron covers and all conductors were lead-encased. The great success of the plant resulted in such rapid growth that within a year material extensions became necessary, among which was the installation of a second Westinghouse generator, which is a duplicate of the one first erected. Still the business increased at such pace that now the thoroughly modern plant about to be described has been installed and the results it has achieved have been so eminently satisfactory, and the efficiencies attained have so far eclipsed any heretofore reached that it has been determined that all future extensions shall be on the lines of this last installation.

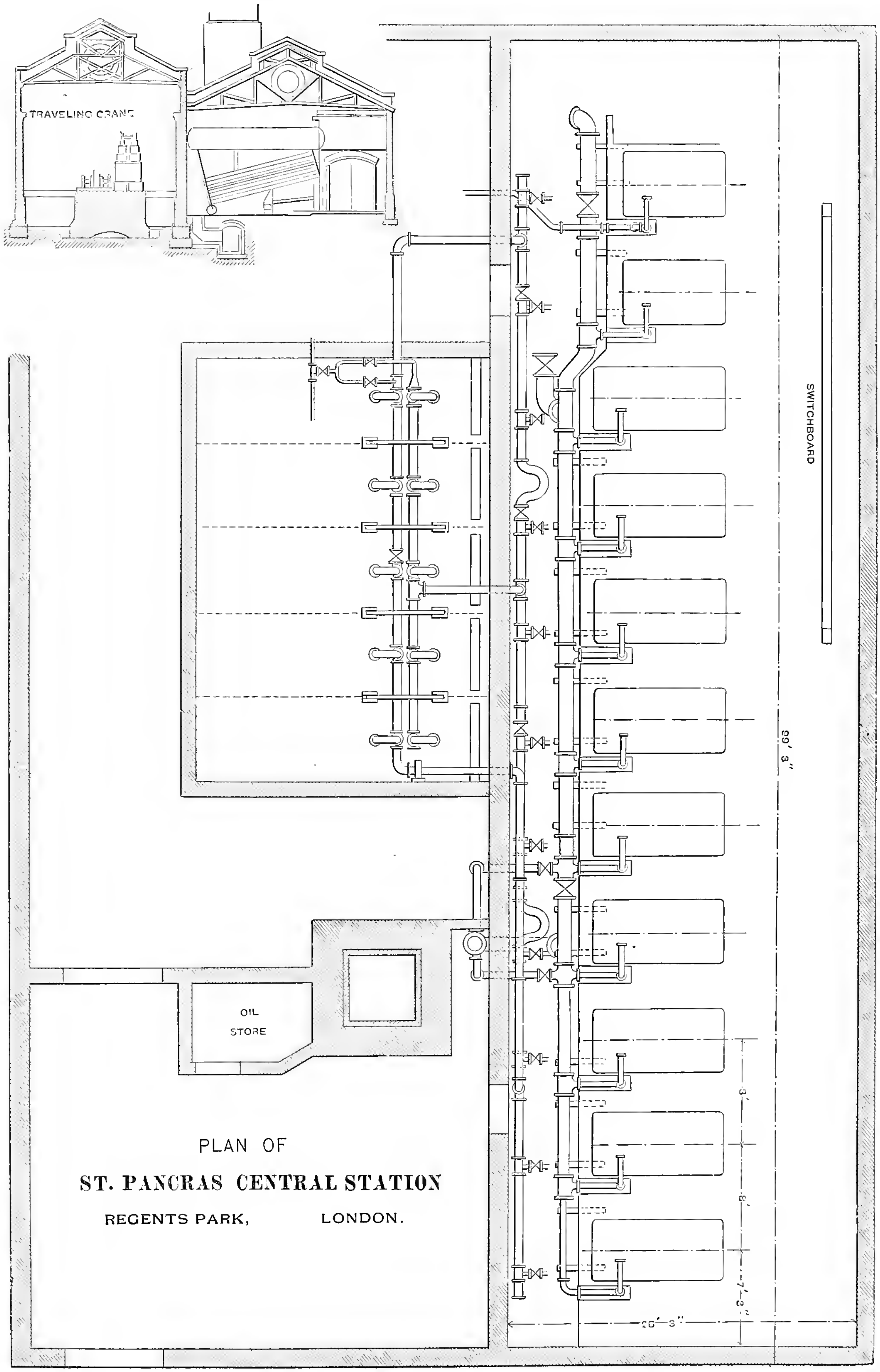
Before proceeding to a description of the plant, it is well to point out that the Pacific Power Company, through the able superintendence of Mr. Ira Bishop, has won the reputation of being able to get more power out of a ton of coal than any other steam power producer on the Pacific coast. Indeed, the attaining of this distinction seems to have been its ambition, with the result that there is probably not to be found west of the Rockies a concern which has given longer years of more patient study and experimenting, or which has made such exhaustive and elaborate tests, or has followed to the most minute detail every item of the cost of power, or has for years required such exacting reports from employees, than has the Pacific Power Company. No item of expense has ever been too small for searching scrutiny; no cost of experimenting or test has ever been a deterrent from ascertaining the facts regarding any feature forming a factor of the cost of steam power. A number of years ago it built at great expense a pipe line through which it pumps condensing water from the bay; for years it has weighed every pound of water going through the boilers and every ounce of coal burned, and it was the first concern on the Pacific coast to buy coal by the amount of water evaporated and to saddle upon the coal dealer the "personal equation" of the fireman. It will not be doubted, therefore, that the Pacific Power Company has reduced the science of central station economics to a fine art. Moreover, until a year since, the Pacific Power Company carried on an extensive engineering and manufacturing business under the name of the San Francisco Tool Company, which was also under Mr. Bishop's management, and which built steam engines, mining machinery, centrifugal pumps, and, in brief, all classes of mechanical engineering work, even to cable railway systems.

It is meet that these features should be enlarged upon, because the experience of the Pacific Power Company is such that it may rightly be considered as a leading authority whose example is worthy of emulation, and as demonstrating that it is a concern which would not introduce a marked innovation in steam engine practice without the soundest of reasons therefor, reached only after the most mature deliberations.

Steam and power station engineers of the Pacific coast will promptly recognize the most interesting innovation of the Pacific Power plant to lie in the Willans engine. Indeed, as this is the first engine of this class that has been erected west of the Rockies, its installation merits more than passing notice and in its adoption the Pacific Power Company has exhibited a thorough understanding of those features of steam engineering which result in the attainment of the highest efficiency from operation without regard to the false economies due to the reduction of first cost of apparatus. Long experience in the building of steam and electric plants had impressed the failings of the various types of high and low speed engines in common use and when the growth of the electric power business of the company made necessary the installation of additional equipment as stated, after exhaustive investigation, the Willans engine was chosen as the one more nearly faultless than any other.

The latest addition to the Pacific Power plant, therefore, consists of a 500 horse power triple expansion, double line Willans central valve engine, taking steam at 200 pounds per square inch and run condensing. This engine is direct coupled to a 500 volt, 300 kilowatt Walker generator, the engine and dynamo set running at 300 revolutions per minute. Owing to the locations of the engine and generator it has been found impossible to photograph them as erected, but the accompanying illustrations present faithful likenesses of them and convey fully as good an idea of the equipment as could be afforded.

In selecting a strictly English type of engine as the most eceonomical, the Pacific Power Company fully realized that for small isolated plants, some of the well known types of high speed engines give very satisfactory results, but there is a limit to their size beyond which prudent builders will not go and which naturally restricts their sphere of usefulness. In fact, it is well known that steam engine practice has developed defects in all ordinary forms of low and high speed outfits. Among the slow rotative speed engines, the famous Corliss type has led all others for efficiency, but owing particularly to the material interval of time consumed in operating the trip valves, the Corliss engines are barred from high speed service which, in necessitating the use of belts and shafting, seriously impairs their efficiency. They are large, cumbersome and consume comparatively enormous floor space—the ratio of space consumed being from 8 to 1, up to 12 or 15 to 1 in favor of the high speed engine, according to whether the fly wheel is belted direct to generators or through countershafting. Further objections to the Corliss engine are frequently found by the absolute want of space in which to erect them, or on account of the great cost of ground room, either of which causes often compel purchasers to place orders for high speed engines, which are in some instances otherwise greatly inferior to Corliss engines both in durability and in economy in the use of fuel. In Corliss engines the number of working parts require considerable care



PLAN OF
ST. PANCRAS CENTRAL STATION
REGENTS PARK, LONDON.

and they are expensive to maintain in the matters of lubrication, belting, clutches and shaft bearings. Moreover, they bend ungraciously to the will of the governor and respond but slowly to its commands.

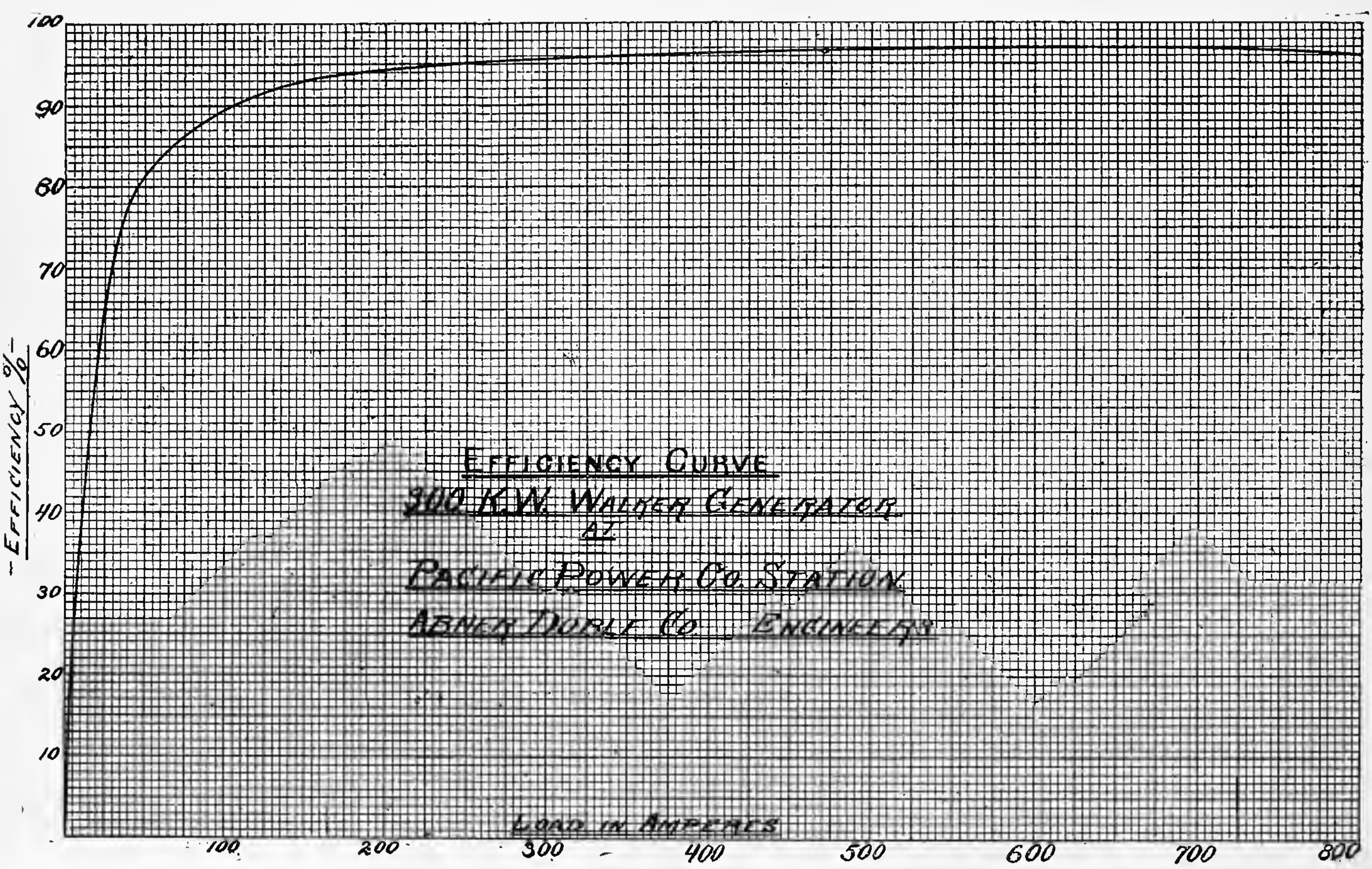
The phenomenal growth in the demand for electric lights for all purposes in the past ten years has modified and radically changed the conditions under which plants were installed, to such an extent that what was then considered the acme of engineering, is now severely criticized, and considered a rudimentary example of the past; and as the demands for engines to be used for electric work increase, the objections to the use of Corliss engines were found to increase in direct ratio. The objections to the Corliss engine all increase its cost and decrease its efficiency, and it is a well known fact that ofttimes belt transmission alone absorbs from 10 to 15 per cent of the power of the engine.

These drawbacks led to the development of the high speed engine of ordinary forms, wherein the different types partially or wholly eliminate the most serious disadvantages of Corliss engines, but gradually faults in the newer forms have developed until now their perfection is no longer conceded. The high speed of the reciprocating parts results in wearing the brasses so that knocking or back-lash can only be avoided by their frequent taking-up, and the number of steam carrying parts which are exposed to the air results in material condensation with loss of efficiency. The oil cups require constant attention and the difficulty of drainage in vertical high speed engines is a serious one.

In brief, the best high speed engine is the one which most nearly conforms with the ideal requirements set forth in the following points:

1st. Maximum economy of fuel.
2nd. " " attendance.
3rd. " " oil.
4th. " " space.
5th. " " time overhauling and making repairs.
6th. Greatest durability.
7th. Self-Lubrication.
8th. Noiseless running.

The broad minded engineer in quest of the greatest refinements that have been accomplished in his art will not be blinded by sentiments of national prejudice, but instead will search the world over for the best. It was thus that an extended and painstaking investigation, by the Pacific Power Company, both at home and abroad, developed the fact that while the American electricians were leading the world in developing electricity and applying it to all industrial purposes, an English engineer, finding himself confronted with conditions differing greatly from those under which American engineers have been working, had quietly met the difficulties above enumerated and conquered them all.



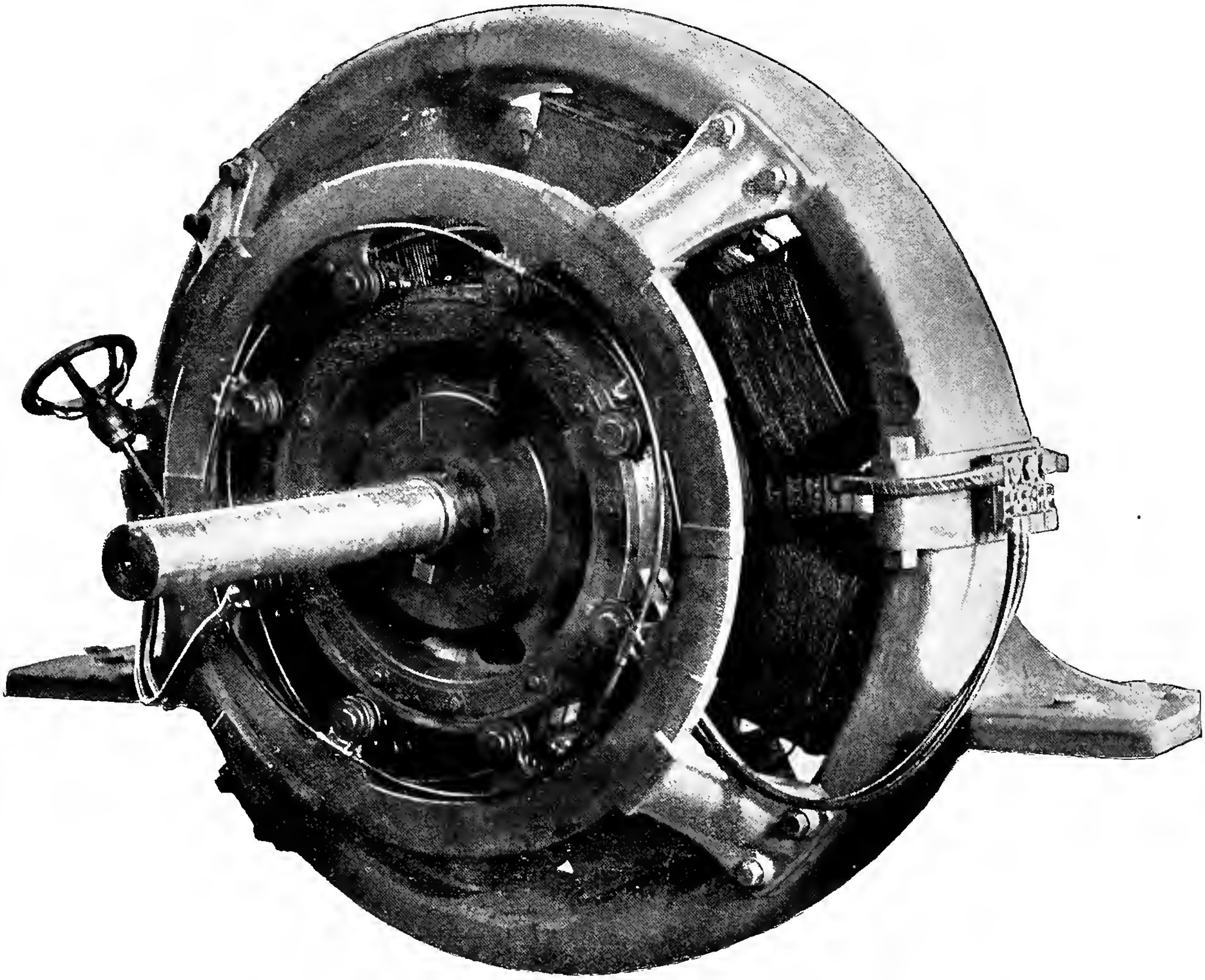
EFFICIENCY CURVE OF THE PACIFIC POWER COMPANY'S WALKER GENERATOR.

The Willans engine installed by the Pacific Power Company is an American-made engine, built by the M. C. Bullock Manufacturing Company of Chicago, upon the plans of Willans & Robinson, Ltd., Thames-Ditton, Surrey, England, where the firm has a very extensive plant, embodying all the improvements known to modern engineering. For several years they have been manufacturing Willans engines in large quantities, making all parts to jigs and templates, and therefore perfectly interchangeable, their standard of excel-

lence being higher than anything that has ever before been attempted in steam engineering, their limits of inspection ranking with the best American manufacturers of fine tools.

It is very interesting to relate that the great success of the Willans engine must be ascribed to the admirable system of manufacture and testing carried out at their works. All the parts of their engines are readily interchangeable and the workmanship is perfect. A writer in The Engineer some time ago paid a visit to Messrs. Willans and Robinson's works. In the course of his admirable remarks on the good work done, he says: "Gages are specially noteworthy, as it is by their universal adoption that absolute uniformity is secured in the diameter of the cylinders, trunks, etc. As an example of this we were shown a large collection of cylinders, from which we were asked to make a selection at random. We did so, whereupon the cylinder was laid on a small surface plate as in Fig. 7. The plate was slightly coated with oil, so as to insure an airtight junction between the two. Now for the test. The gage for this size of cylinder was dropped into the cylinder. Did it fall to the bottom? No; it remained supported at the top on a perfect air cushion, and so exact was its fit, that when struck with a hide mallet, stamped upon, it responded by merely vibrating up and down, alternately compressing and being raised again by the cushion on which it sits, and gradually settling down to its normal state of suspension. It is this easy movement that makes the experiment so pretty, showing how exactly the necessary diameter to insure it, and at the same time entirely imprison the air beneath, has been hit."

The same writer gives another instance which shows the perfect workmanship which is secured by Messrs. Willans & Robinson. "The 60 indicated horse power compound engine—shop engine—the upper parts of which were exhibited at the Institute of Civil Engineers on April 18, 1893, is a proof to show of what these engines are capable. It should be remembered that the parts exhibited had been running since July, 1889, and had undergone unusually severe running, probably equal to five years of ordinary running. No part had previously replaced except one piston ring, and the signs of wear were very slight. An important fact in connection with the replacement of parts was the astonishing rapidity with which it was done, as all the parts except the base were removed during the dinner hour on April 18, and replaced by similar new parts taken from the stores, allowing the engine to be started at two o'clock."



THE WALKER GENERATOR INSTALLED BY THE PACIFIC POWER COMPANY.

As the Willans engine is a decided novelty in the Far West, it is fitting that in view of its extraordinary economy, it should be fully described:

The engine is single acting, and on the "constant thrust" principle—that is to say, the connecting rods

are always in compression. All the brasses are held close together, both upon the up stroke and upon the down stroke. The latter is the working or effective stroke. During the first portion of it the steam pressure on the pistons, of course, presses all parts against the cranks and the crankshaft against the lower main bearing brasses: in the later portion of the down stroke

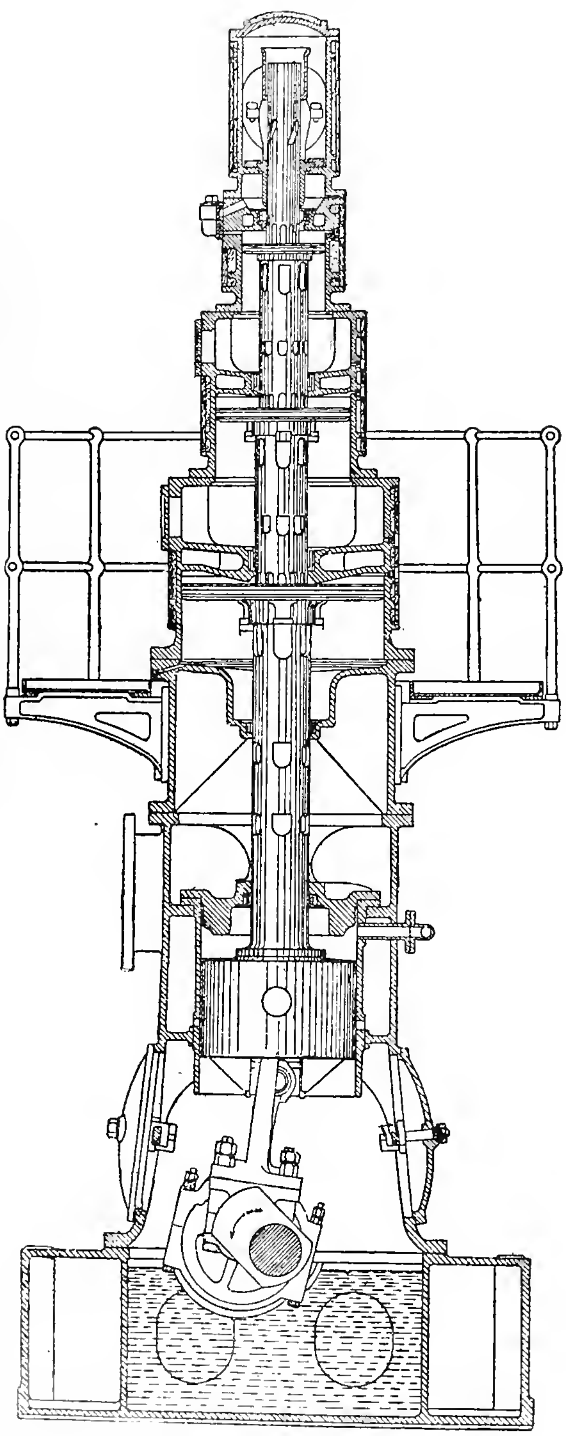


FIGURE 1.—OUTLINE SECTION OF A TRIPLE EXPANSION CENTRAL VALVE ENGINE.

the inertia of the parts, as they are brought to rest by the changing angle of the crank, also helps to keep them in compression. On the up stroke, when no work is being done, and when the steam is being merely exhausted from the several cylinders, the inertia of the parts, as they undergo acceleration by the crank, also keeps them in compression for the earlier portion of the stroke; in the latter portion they are cushioned by the arrangement to be described. The result is that in no part of the stroke, up or down, do the parts tend to separate; consequently there is a total absence of "back lash" or "lost motion," and "knock" cannot arise as it would if the engine were double acting, particularly in view of the high speed adopted.

The piston speed, however, is lower than in most engines, and the wear in cylinders and piston rings is consequently small, while that in the brasses owing to the total absence of hammering and of back lash, is very small indeed. The valves working inside the piston rod in the manner shown on this page, give an excellent distribution of steam and unequaled drainage for water. The high speed is in itself conducive to economy, and the Willans engine, as proved by many tests of undoubted authority, stands absolutely at the head of all types of steam-engine as an economical motor—the largest and best types of Corliss engine not excepted. With a small engine indicating only 20 h. p. (at 400 revolutions per minute) a consumption of less than 13 lbs. of steam per i. h. p. per hour, condensing, has been recorded, and a little over 18 lbs. non-condensing.

The outline cut on this page shows a triple expansion condensing engine in section (through one line of cylinders). The steam is distributed throughout by the hollow piston rod. It enters from the steam chest by the oblique cut-off ports shown near the top of the piston rod. By the movement of the line of piston piston valves, which work inside the piston rod or trunk, driven by an eccentric, the steam passes into the high pressure cylinder, at the beginning of the stroke, by the ports shown above the high pressure piston. It is important to remember that this ring of ports is the only inlet to and outlet from the cylinder, and it moves up and down with the piston.

The action of the valve inside is shown in detail in Fig 2, which represents it in the exhaust position. The valve gives just the same steam distribution as an ordinary slide valve, with a slow cut-aff at about three-quarter stroke. The actual cut-off is, however, effected by the oblique ports in the steam chest, which, at a point in the stroke, either prearranged or controlled by the governor, pass behind rings, or a sleeve, so disposed as to prevent the further supply of steam for that revolution. As the cut-off motion is the same as that of the pistons themselves, the cut-off is very prompt, and shows a sharp corner in the diagram.

It must be impressed that the hollow piston rod passes completely through the line of pistons, and through the ends of the cylinders. The reason the eccentric is on the crank-pin, and not on the shaft as usual, is that the valve-face (i. e., the inside surface of the hollow piston rod) moves with the pistons. Consequently the valve-motion required is a motion relative to the pistons, and this is obtained by mounting the eccentric on the crank-pin, which like the piston-rod, moves up and down with the pistons. Though its lead is set out differently from that of an ordinary eccentric, its effect upon the movement of the valves is exactly the same.

It will be noticed that the upper crank-pin brasses of the connecting-rods are wider than the lower ones. This is because the upper brasses alone are intended to be in actual contact with the crank-pins; the lower ones are only a stand-by in case of accident. All the moving parts of the engine designed to be strictly in

constant thrust and the connecting rods are always in compression, never in tension. From the fact that the upper or working brasses never leave the crank-pins, and so are never exposed to hammering action, however slight, they exhibit great durability when proper-

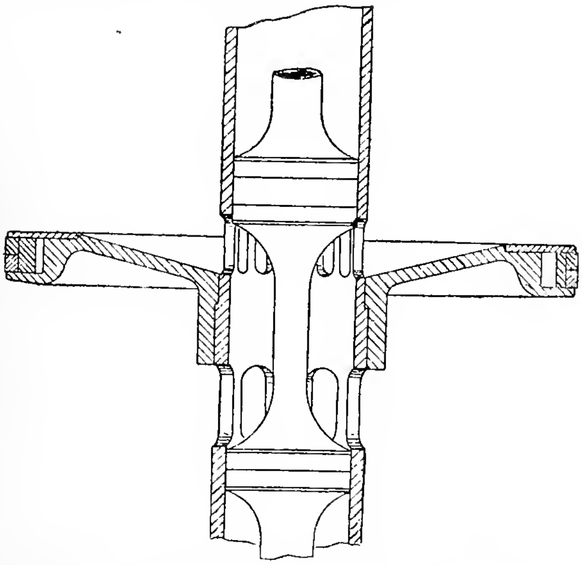


FIGURE 2.—A SECTION OF THE PISTON OF A WILLANS CENTRAL VALVE ENGINE.

ly lubricated; at the same time it is evident that no wear which can take place in them however great, can lead to knocking, as the connecting-rods will follow up the wear automatically. But as the lower brasses, to be useful as a stand-by, should not be too far from the crank-pin, the wear should be taken up when it becomes excessive, say as soon as it reaches 1-32 inch, care being used that the lower brasses are not brought actually into contact with the crank-pin, and that sufficient slack is left to insure an audible knock if the engine is allowed to race, so as to attract attention.

In the sectional view appearing in the advertising pages (viii) appears a two-line Willans central valve compound engine showing the transfer chambers and the spiral cut off sleeve. A further reason for the moderate wear of the brasses and eccentric straps is that they dip bodily into the lubricant in the crank chamber at every revolution. In doing so they splash it over the main bearings and to the upper ends

After the steam has worked expansively in the high pressure cylinder, the valve passes above the ports (see Fig. 2), and opens communication from the working end of the cylinder, viz., the space above the piston to the space below it, which is called the high pressure receiver; but which is equally a steam chest for the intermediate cylinder.

During the up stroke the steam is simply transferred from one side of the piston to the other; the whole cylinder, including the "working end," at that time forms part of the receiver. When the next down stroke commences, the steam in the high pressure receiver is passed into the intermediate cylinder. It enters the hollow piston rod again from the receiver by the ring of short, square headed holes shown, and passes from the piston rod to the cylinder by the ring of ports shown just above the intermediate piston. Cut-off, in this case is given by the square headed ports passing into the gland in the intermediate cylinder cover, and so losing the supply of steam from the high pressure receiver or intermediate steam chest. The cycle is exactly the same as already described for the high pressure cylinder, and at the end of the second revolution the steam fills the intermediate receiver. Thence, in the third revolution, it passes into the low pressure cylinder, and in the second, or exhaust, half of that revolution, it passes from the low pressure cylinder, viz., from its upper end to the lower end, without material change of volume or pressure. It is only during the first half of the fourth revolution that it finally passes away from the "transfer chamber," the latter being in permanent communication with the condenser. The full cycle thus described is that of a triple expansion Cornish engine. In each separate stage of the expansion the complete Cornish cycle can be traced, and it is evidenced by two separate diagrams from the upper and lower end of each cylinder. The diagram from each receiver, or from the "transfer chamber" represents (as in every Cornish engine) the removal of back pressure on the down stroke, forming a virtual addition to the diagram from the upper end of the cylinder.

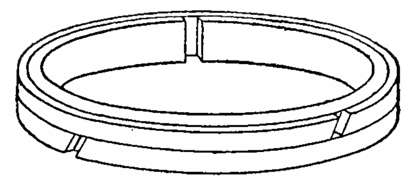


FIGURE 3.—THE PISTON RINGS.

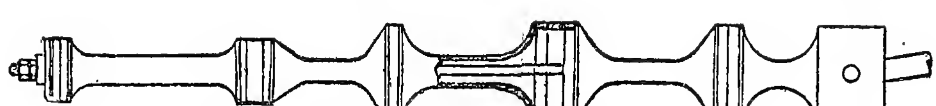


FIGURE 4—A LINE OF WILLANS' VALVES.

of the connecting-rods, and eccentric rods, and into the guide cylinders as well as into that part of the hollow piston-rod where the guide works. The lubrication of the working parts (other than steam pistons and valves) is thus completely automatic, and gives no trouble whatever.

The principle of working with all brasses "in constant thrust" is of the utmost importance and value, and is the primary cause, not only of the silent running of the Willans Engine, but of the almost complete absence of wear in the brasses. It is the condition which alone makes continuous high speed possible.

One of Mr. Willans' latest improvements in his engine was the system of packing rings shown in Fig. 3.

A complete line of valves (from a compound engine) is shown in Fig. 4. The piston valves are not steam packed. They are separated by suitable cast distance pieces with their ends faced to lie against the rings. All are strung together upon a steel tie rod, with a kind of spring washer under the nut at the end.

The gland rings, used instead of stuffing boxes, are shown in Fig. 5. They are upon exactly the same sys-

tem as the main piston rings; they are simply piston rings pressing inward instead of outward and guarded against end play in exactly the same manner. Steam is admitted behind them as in the main pistons.

The water above each piston is swept downwards by the exhaust steam into the space below during the whole of the exhaust stroke; it has not to be carried by the piston to the top of the cylinder, and then driven out suddenly through the port in a more or less

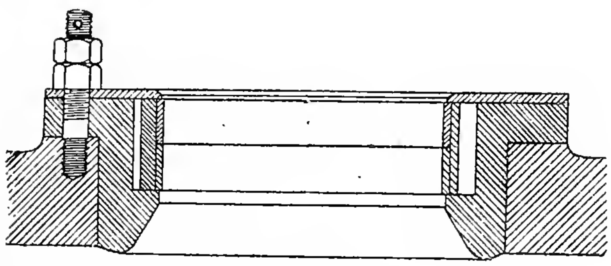


FIGURE 5.—STEAM GLAND BOX.

upward direction, as is the case in other forms of vertical engines. The Willans engine has therefore unique advantages in getting rid of water from the cylinders, apart from the action of the relief-valves.

Reference has been made to the fact that the connecting rods, and all the moving parts, are constantly in compression—a condition rendered possible only by the fact that the pistons are single-acting, giving no pull to the crank upon the up-stroke, but only a push upon the down-stroke. In any engine running at high speed, however, the moving parts can only be kept in compression upon the up-stroke by very powerful cushioning, which is rarely obtained in other high-speed engines without excessive compression in the cylinders, involving wasteful use of the steam. Sometimes, when a high speed engine exhausts into a vacuum, sufficient cushion cannot, by the usual means, be obtained at all. In the Willans engine very little compression is given in the steam cylinders, for little or none is required; the requisite cushioning is obtained independently by special means, the subject of a separate patent. It is in fact provided, without the addition of a single moving part to the engine, by the guide pistons. These on the up-stroke, compress the air contained in the guide cylinders, and thus any desired amount of cushion can be obtained according to the clearance allowed. The work expended in compressing the air is given out again by the expansion on the succeeding down-stroke, and the loss, when the engine is running at good speed, is proved by indicator diagrams to be too minute to be worth consideration (as shown in diagram on page 46.) There are holes in the guide cylinders, which are uncovered by the guides at the bottom of the stroke. As the casing or chamber which surrounds the guide cylinders and forms part of the framing of the engine is open to the atmosphere, it is evident that the air compression always commences at atmospheric pressure, and is constant and invariable in its results, whatever alteration may be made in the destination or the pressure of the exhaust steam.

In the low-pressure cylinders of all engines, and in the high-pressure cylinders if large enough to be so treated, internal relief valves are fitted, consisting of a gun-metal plug screwed into the top of the low-pressure cylinder. The plug is pierced by holes, covered by a single thin gun-metal disc. When the disc is raised, there is free communication between the cylinder and the receiver or steam chest above it. It is kept down under ordinary circumstances by the excess of the receiver pressure over that in the cylinder; therefore no spring is required, and there is no part liable to get out of order. If from water in the cylinder, or any other cause, the pressure rises above that in the receiver, the valve lifts, and though the water is only passed back into the receiver, the relief is found to be sufficient, and in fact far more effective than that given by ordinary external relief-valves. Engines so fitted have been tested by discharging a cubic foot of water suddenly into the steam-pipe; also by connecting the steam-pipe with the water-space of the boiler (by a half-inch pipe, with a difference of 80 lbs. between the pressure in the boiler and that in the steam-pipe)—without any injury to the engine in either case. In cases where internal relief valves cannot be used, ordinary external valves are fitted. Relief-cocks are also fitted upon the guide cylinders, in order to avoid compressing the air in them when the engine is being turned by hand, and to facilitate starting.

All these points—viz., the special piston (and valve and gland) rings, the special arrangements for drainage, and the use of the "Cornish cycle" in all stages of expansion—are of great importance, and are peculiar to the Willans engine.

The line of piston valves is driven by an eccentric on the crank pin. It is necessary that the source of motion for the valves should itself move up and down with the pistons, since the ports which have to be opened and closed also move up and down. There is an eccentric rod, which takes on to a hardened pin in a valve guide piston; the latter works in a bored guide formed inside the main guide piston.

There are two connecting rods to each line of pis-

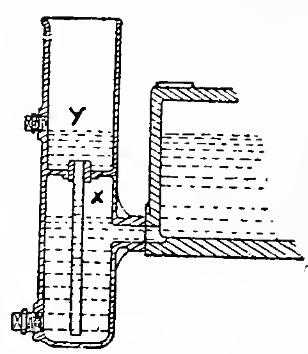


FIGURE 6.—THE LUBRICANT GAUGE.

tons, one on each side of the eccentric, the eccentric rod plays between them. The cranks and all working parts, except the cylinders and valves, are lubricated by the splash of the cranks in the crank chamber, where the lubricant usually consists of a mixture of oil and water. The guides and the pins at the upper ends of the connecting rods and eccentric rods are readily reached by the splash. The cut-off in the high pressure cylinder is effected by the movements of the ports in that part of the hollow piston rods which projects into the steam chest. The engines can be fitted with variable expansion gear when desired. If an early cut-off is desired, the gland is raised a little by packing pieces between it and the cylinder top. In that case the ports enter the gland earlier, and the steam is cut off earlier.

Fig. 6 shows the lubricant gage. The part X, acts as an air vessel, to prevent violent oscillation of the surface at Y. Since the gage communicates only with

the lowest part of the crank chamber, very little oil passes into it, and any overflow which takes place from Z consists almost entirely of water. The gage enables the quantity of lubricant in the crank chamber to be easily ascertained at any time.

It is the Willans engine that "Machinery," one of the most conservative of the technical journals of London, states: "It is impossible to speak too highly of this type of engine as an efficient and economical prime mover. The manner in which it is constructed is worthy of all praise. On former occasions we have

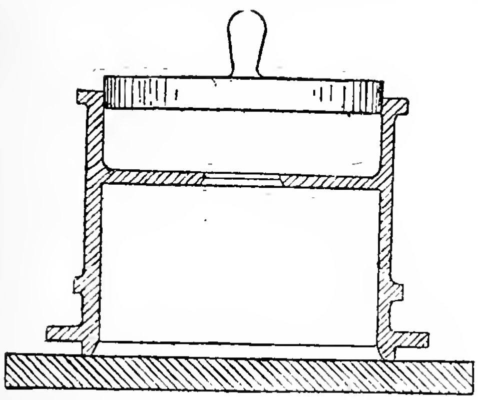


FIGURE 7.—TEMPLATE SUPPORTED IN CYLINDER BY AIR.

discussed some of the difficulties of making interchangeable parts. At the Thames Ditton Works all the difficulties have one by one been surmounted, and it is believed that few engines are manufactured with such care respecting the accuracy of the machine work and the soundness of the materials employed as the Willans engine. It will be noticed that the engine is mostly composed of turning and boring work, the kind of workshop tooling we all seek to employ to as large an extent as possible in our designs."

The English practice of operating central stations has been largely based upon the perfection and almost universal adoption of the Willans central valve, and one of the most striking features of central lighting stations equipped with central valve engines is the arrangement of a line of combined engines and dynamos of 100, 200 and 300 h. p. units, coupled up in parallel, so that all but one of the engines are loaded to their full capacity, while the one partially loaded engine (all of the other governors having gone out of action) is doing all the governing. In other words, it takes care of all variations or fluctuations of load within the limit of its capacity. For instance: Calling at any one of the numerous central stations using Willans engines (in London) at about 10 o'clock at night the visitor will find the complete plant of ten or more engines coupled direct to the dynamos, running with not more than two attendants—an engineer who looks after the engines, and an electrician to take care of the switchboards. Of these ten engines, nine would be loaded to their full capacity so that the governors have gone out of action, while the tenth engine will be running with a light load—possibly one-half its capacity—thus being in position to take care of the fluctuation of the load, as lighting districts were thrown on or off. When the load decreases about 11 o'clock so that the second or No. 9 engine will not be loaded to its full extent, No. 10 is shut down, and No. 9 will do the governing, until later in the evening, when the load being removed from No. 9, that engine will be shut down and No. 8 will take up the duty of governing, and so on, engines being shut down from time to time as the load decreases. This system has great flexibility, and possesses many advantages over the ordinary system of making each engine automatic in its action, and compelling it to take care of certain sections or districts with all its variations of load, for it is a well-known fact that there is as much waste of power in running an engine and dynamo underloaded as there is in overloading.

For central station work the use of the central valve engines with direct coupled dynamos permits the use of smaller units than is ordinarily used in central stations; this, of course, decreases the first cost in the purchase of relay outfits, for it is obviously cheaper to purchase a 100 or 200 h. p. unit than it is to buy a 500 or 1000 h . p. unit, and when a number of them are coupled up in parallel, a majority of them can be worked at full load, which is the most economical condition for both engine and dynamo. At the same time one engine is taking care of the fluctuations of load, thus confining the governing of the plant within a smaller range between full load and no load than it is possible to do with other systems. In some English stations this point of economy is carried out to such an extent that where they are using 200 or 300 h. p. units they use a 100 h. p. engine for a relay, and another of the same size to do the governing for the large units.

This peculiarity of English stations is fittingly exemplified in the St. Pancras electric lighting station at Regents Park, London, the interior of which is illustrated on page 37. From tests made by Prof. Robinson to determine the efficiency of the plant it was found that with a load of 680 amperes at 118 volts, the steam consumption was 18.65 lbs. per electrical horse-power, working condensing and with dynamos separately excited, the boiler pressure being 173 lbs. and the boiler evaporation being 9,747 pounds of water per one pound of coal. This gives a consumption of 1.91 lbs. of coal per electrical horse-power per hour, an efficiency rarely attained in steam plants.

The "London Electrician" of February 2, 1894, contained a communication from Messrs. Siemens Bros.

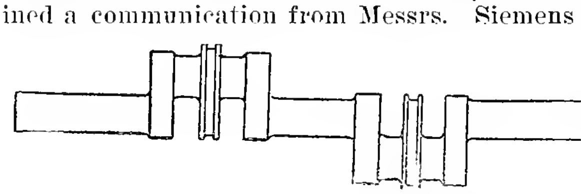


FIGURE 8.—A WILLANS CRANK SHAFT.

& Company, Ltd., in which reference was made to tests made by Prof. Kennedy, consulting engineer, on a Siemens-Willans set for the Glasgow Corporation. "We venture to think," wrote Mr. Al. Siemens, Director, "that the figures in the enclosed table are of some interest as to the best of our knowledge, so high an efficiency as 88 per cent, has not been previously obtained. The curve which we enclose is also remarkable." This is reproduced on this page, and the results of the test are shown in the following table:

Load	Pressure in Steam Chest	Revolutions per Minute	Amperes	Vo'ts	I. H. P.	E. H. P.	Water per E. H. P. lbs.	Efficiency Per Cent.
Full	139	346	1001.0	225	343.0	302.0	23.08	88.04
3/4	112	347	740.0	225	262.0	223.2	27.01	85.11
1/2	88	344	515.0	225	197.2	155.3	31.63	78.76
1/4	56	345	236.6	225	112.2	71.2	47.09	63.44

On page 40 also appears the efficiency curve of the Walker generator now in operation in the Pacific Pow-

er plant, which evidences the excellence of the equipment.

It is interesting to note, in addition, the results of tests made by Prof. Unwin, F. R. S., on a triple expansion, 40 h. p. condensing Willans engine, the results Institute of Civil Engineers, London, as follows:

Barometer, lbs. pressure per square inch.. ..	14.58
Steam chest pressure from gauge (absolute)..	184.58
Condenser back pressure..	0.75
Mean admission pressure absolute..	175.
Revolutions, total during trial..	69.420
Duration of trial, minutes..	180.93
Mean revolutions per minute (actual)..	383.7
Total mean pressure referred to L. P. Cylinder	34.87
Indicated Horse Power..	29.84
Discharge from hot well per hour..	380.3
Water per I. H. P., hour..	12.74

An examination of the Willans-Walker set in operation at the works of the Pacific Power Company impresses one immeasurably with the perfection of the combination. The apparent absence of any moving part whatever except the governor wheel, the armature and a small portion of the shaft, and as well as the noiselessness of running, reminds one of a direct-connected water wheel plant, except that the steam plant makes even less noise than the water plant. Not a motion or a steam carrying part is visible and practically no heat is radiated therefrom, which of course increases economy. At the Pacific Power plant the Willans-Walker has been in continuous service from Sunday afternoon to Sunday morning each week since its installation, six months ago, and, in fact, the plant was installed for just such service and judging from the records of similar equipments, it is safe to predict that it will be capable of continuing under similar use for years.

In conclusion it may be stated that the installation of five other Willans-Walker sets similar to the present one has been determined upon and, in fact, the foundation for the second set has already been erected. This will give the Pacific Power Company a nominal capacity of 3,000 horse power and the plan of installation closely resembles that of the St. Pancras vestry station previously described. The work of construction has been carried out in a most thorough manner by the Abner Doble Company, agents for both the Walker and the Willans equipments and who have throughout acted in conjunction with the Pacific Power Company in the execution of the engineering details of this interesting and most efficient plant.

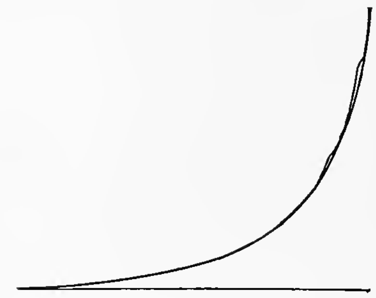


Diagram taken from air-cushion cylinder of the Central-valve Engine, direct coupled to general Electric Co. Multipolar generator.
FIGURE 9.

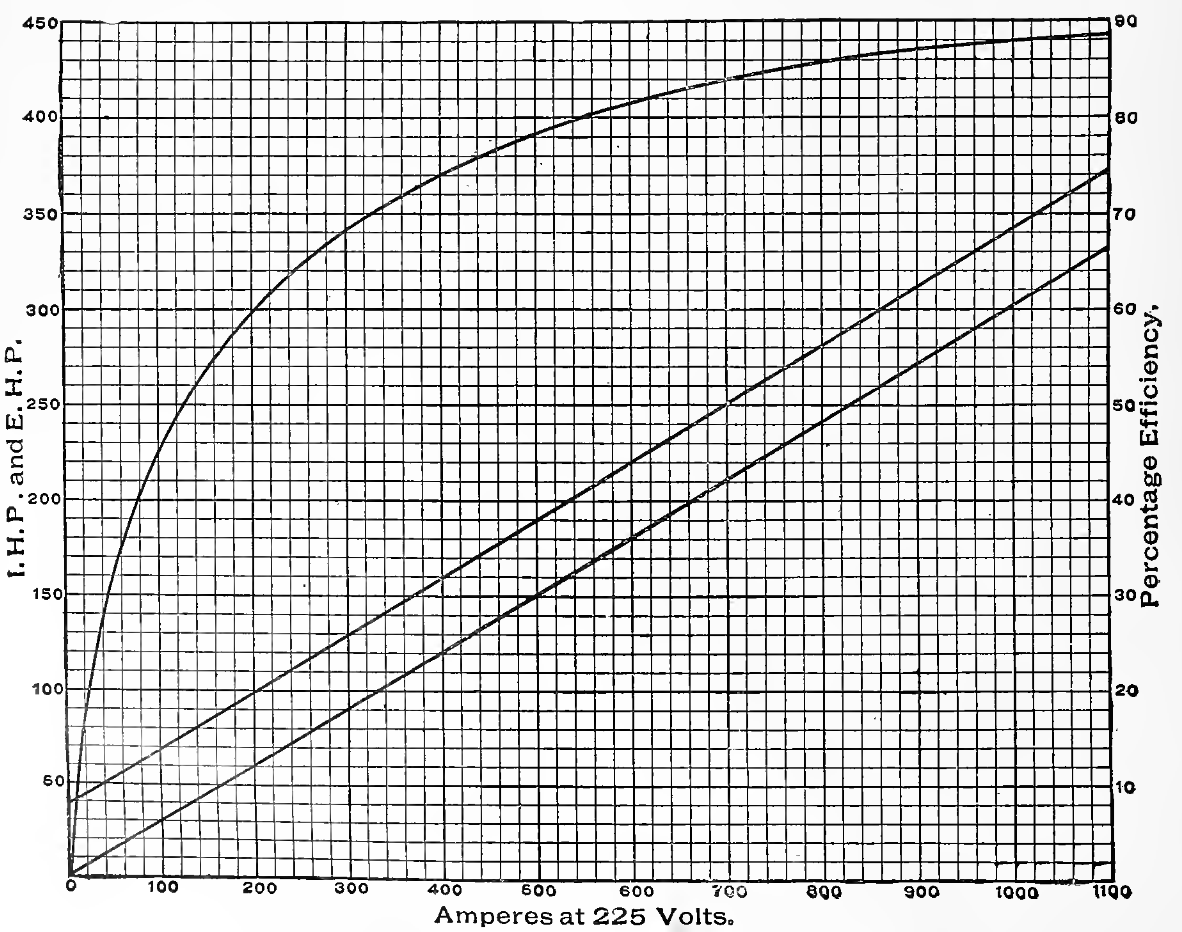


FIGURE 10.—EFFICIENCY CURVE OF A SIEMENS-WILLANS SET.

Mining

ARE MINERAL LODES OF ELECTRICAL FORMATION?

By Sidney Sprout.

Whether the souls of the departed remain on earth after death will probably forever remain a disputed question, but it is certain the fruits of the minds of some do so remain in the forms of writings.

It was thus that there recently came to the writer the ideas of one in the form of a book written by a long since forgotten civil engineer named Hopkins, who lived in the early part of this century and in this work the author attributes the deposits of metals in quartz ledges to the action of the earth's magnetic lines of

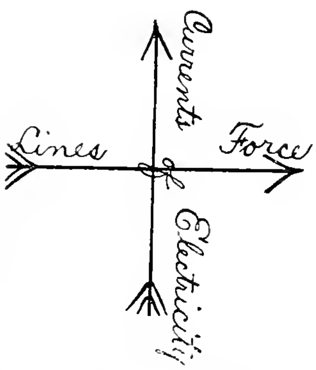


Figure 1.—The relations of electricity and magnetism.

force, giving in addition, very interesting descriptions of his ideas of geological formations. He theorizes clearly how the quartz formation is of water origin, instead of in accordance with the well advanced theory that quartz owes its formation to molten material being forced up through the fissures of the rock. The latter idea, of course, follows the now disputed theory that the earth is a body of molten matter with a thin crust of cooled material forming its surface, but whether the former or the latter theory is correct is not of necessity to be discussed now, but for the present we will accept the theory favoring the water formation of quartz.

Hopkins' book was praised very highly by its owner, Mr. Almarin B. Paul, M. E., who secured it years ago and who has reason for believing it to be the only copy of the work in the United States. Up to the present time it has been but hastily glanced through, but this cursory perusal has suggested an effort to continue the theories advanced by the author.

Although the laws and principles governing magnetism and electricity are now well understood and form one of the leading sciences of the present time, it must be remembered that those connecting electricity and magnetism are of comparatively recent date, and while the author describes some experiments with the galvanic battery, they are insignificant in comparison with present methods of electro-magnetic measurements and manipulations. Hopkins' work, therefore, was not appreciated during his day, probably because his theories were too far advanced for the times and possibly because he was himself not able to satisfactorily explain them. His book at least does not make the subject clear in the light of the present, but could he have lived at this day there is no doubt but that he could have given a very definite and substantial theory of the electro-deposition of metals in the earth's fissures. The ideas gathered from Hopkins' book form the basis for the following:

One of the most difficult matters to explain to a person having no knowledge of the principles of electricity and magnetism is the distinguishing features of the two forces, but it is easy to remember that whereever magnetic lines of force and currents of electricity exist, the former invariably crosses the latter at right angles, or vice versa. This is shown in the dynamo in which the magnetic lines of force pass from field to field, cutting the armature wire at right angles and inducing in it a current of electricity, which is also at right angles to the magnetic lines of force. When this is understood, next consider the earth itself, which, as every one knows, is a huge magnet, in which the magnetic lines of force run from pole to pole, parallelling the geographical line of longitude. It naturally follows, therefore, that as the magnetic lines of force in the earth extend in a northerly and southerly direction, the currents of electricity will be at right angles to them, or mainly in an easterly and westerly direction. The mariner's compass proves the existence of magnetism in the earth, and every telegrapher can relate experiences demonstrating the occurrence of earth currents of electricity.

To advance another step; if the terminals of an ordinary battery be immersed in any metallic solution such as sulphate of copper, metal will be taken from one wire—the positive one—and transmitted electrochemically through the solution and deposited upon the negative wire. This phenomena embodies all there is to the physical principle underlying electroplating and the electro-deposition of metals, and wherever a current of electricity traverses a path moistened with a solution of any metal, the deposition of that metal is bound to take place. It must be clear that the earth is a huge dynamo, revolving in a weak magnetic field and generating internal currents of electricity that, though of low potential, are of enormous volume because of the immeasurably low resistance of

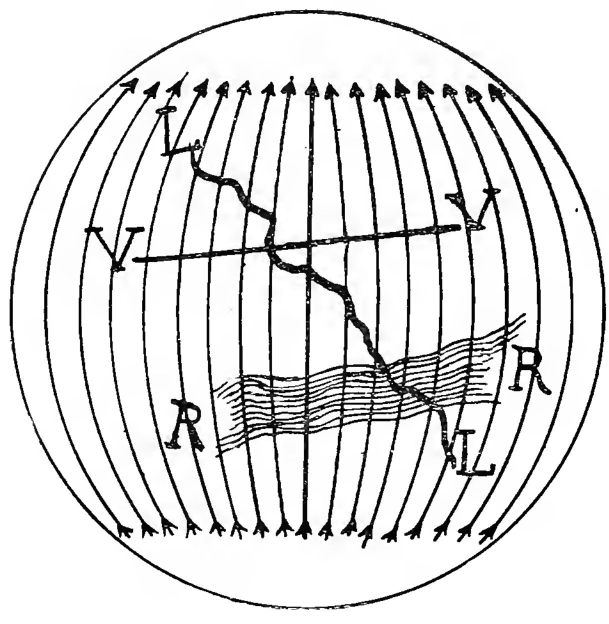


Figure 2.—The earth as a dynamo.

the conductor travers d, namely, the earth itself. When it is understood that it is the ampere that causes the precipitation of metal in the deposition bath, and that the volume of earth currents must reach millions and millions of amperes which have been flowing through the countless ages of the past even from pre-geological times, it will be seen that the theory which attributes the existence of metal in the earth's crust to electro-deposition can not be attacked on the ground of physical impossibility.

Such enormous currents of electricity flowing transversely around the world must necessarily seek out every possible path and as the resistance of different portions of the earth's crust vary materially according to its compositions, paths of current flow are selected according to the channels of least resistance presented, for, in electricity, the shortest path is the path of least resistance. Though the trend of current flow is parallel to the equator, its actual course varies in different locations because of the existence of fissures and strata of metal bearing rock. These fissures or ledges run in all directions and depths and all serve as conductors of earth currents, but for convenience, assume as in Figure 2, that L L is a crevice in the earth's surface, extending through the formation of metal bearing rock R R, and the vein of, say, iron ore, V V. If the fissure L L is filled with or contains a solution of gold in whatever quantity (as in ocean water, for instance),

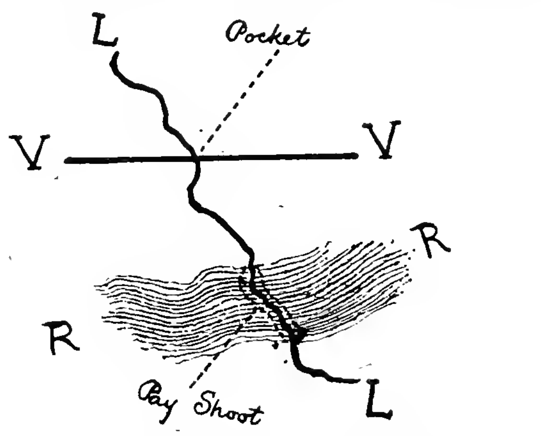


FIGURE 3—A SUGGESTION ON THE FORMATION OF "POCKETS" AND "PAY SHOOTS."

it will be found that the earth currents will take the paths afforded by R R and V V, depositing the gold held in solution in the fissure L L. From the time of the creation this electro-deposition process has been going on until the fissure has become filled with crystals of the solution, interspersed with deposits of gold. As water presses against the sides of a vessel when crystallized by freezing, so do these crystals become forced together under such enormous pressure as to change their form from that of crystals to that of quartz. Sometimes the action of the pressure is such as will grind the gold to small particles: sometimes grinding does not occur, when the deposited gold remains as a free vein: again, if the sides of the fissure are soft, or if they ever were soft, the deposit of gold grows larger and larger and a "pocket" of gold is formed at the intersection of the fissure L L and the vein of ore V V, as seen in Figure 3. If on the other hand, the deposit occurs at the intersection of the fissure L L and the formation of metal bearing rock R R, of a moist nature, a good "pay shoot" will occur as in Figure 3.

According to this theory, if a ledge runs north and south (or nearly so), and is crossed approximately at right angles by, say, a vein of iron ore, one may expect to find at the intersection a "pocket," while, if it crosses a strata of metallic rock, the intersection will probably prove to be a "pay shoot."

The writer, not being familiar with mining, can not say that these are the conditions as mining engineers find them, but feels that the idea may bring out the views of those interested, possibly with the result that new and more efficient methods of locating deposits of metal may be adopted which will prove to be more certain and far less costly than the present mode of sinking expensive shafts or boring experimental tunnels.

Personal

Dr. F. A. C. Perrine and family are spending the summer at the home of his parents in Freehold, N. J.

Mr. F. V. T. Lee, of Stanford's '97 class in electrical engineering, has become associated in the engineering staff of Mr. Jno. Martin, Pacific Coast agent of the Stanley Company.

Mr. Leon Porsh, one of the pioneers of Edison installation, has returned to San Salvador, Central America, after a visit of a month or more in San Francisco. His exceptional ability as an installing electrical engineer has won a very lucrative business for him in that city.

Mr. C. C. Chesny, of the Stanley Electric Manufacturing Company, and who has won fame and fortune through the "S. K. C." (Stanley, Kelley, Chesny) system of that concern, has spent a fortnight in San Francisco visiting the various transmission plants in California and returned East on June 16th.

Mr. W. Stuart Harrison, electrician for the Oriental Telegraph Company, with headquarters at Hong Kong, passed through San Francisco last month en route for London, whither he goes for a period of rest and recreation. The week spent by Mr. Harrison in San Francisco won for him many friends who look upon his brief sojourn here as a rudeness of fate in that it was so very short.

CENTRAL CONDENSERS.

There is a growing tendency in some large power-plants to introduce condensers of the so-called "central" type, one large condensing apparatus being used to maintain a vacuum into which all the various engines, pumps and compressors discharge their exhaust steam. This central condenser has its own air and circulating pump, and forms a sort of negative generator at the opposite end of the power chain from the boiler, with a steady "pull," so to speak, upon all the motors in the establishment. Apart from the general economy of the use of a condenser, "central" condensers possess the additional advantage that a great number of small engines, pumps, and the like, which, in ordinary plants, would be puffing and barking away into the atmosphere, are operated, condensing as a matter of course when there is a general vacuum tank at hand. Such central condensers might be profitably installed wherever there is sufficient water available. —Cassier's Magazine.

Hydraulics

THE GOVERNMENT OF WATER POWER.—I.

By Mark A. Replogle, Engineer.

The regulation of the speed of a water-wheel in a power plant is determined by four distinct factors:

1. Changes in load or requirements for power;
2. Time required for gravity to generate power;
3. Capacity of the plant for stored energy; and,
4. The governor or mechanism that should automatically combine the above three factors in such a manner as to obtain even speed or good regulation.

These factors, clearly defined, are bases from which intelligent calculations can be made showing the possible efficiency of government in any water-power plant.

Let it be understood that the word "government" refers to that regularity of motion or speed that is so desirable and necessary in our finest manufacturing and electrical power plants. Absolutely uniform speed can be maintained only when there is no change in the power supply and no change in the friction or work of the plant; but if the above factors are carefully considered and judiciously manipulated or applied, the variations of speed may be so reduced that the results can be called perfect government.

The speed of a plant at all times is a resultant of opposing forces establishing an equilibrium or balance. The power supply has a tendency to increase speed and the work has a tendency to decrease it. Speed may be varied by increasing the power supply or by decreasing the power supply; by increasing the amount of work performed, or by decreasing the amount of work performed; and any one of the above changes causes instantly a change in the speed; but the amount of change in speed depends entirely upon the amount of change in load, the time it takes gravity to generate power, the quantity of energy in store, and the operation of the governor in opening or closing gate.

Since it is impossible for any automatic governor to change the power supply at the instant a change has been made in the load or work of a power plant, it is very plain that there must be fluctuations in the speed. The problem of government is to narrow these fluctuations to such an extent that the speed will be constant as far as practical operation is concerned. The finest government ever obtained consisted of changes in speed, but within narrow limits. The speed of a well governed single-crank engine changes four times every revolution.

The first factor in governing, "the changes in load," is a variable one, and is limited only by the character of the work done by the water-wheel. The changes may range from zero to the full power of the wheel instantly, making government a more difficult problem than it would be if the changes were limited in number or quantity. It is plain that if an even speed is retained when a change in load is made, there must be at the same instant a corresponding change in the power supply. This is an impossibility in automatic governing, for several reasons: the speed must change in order to inspire the speed governor; following this, the speed governor causes the valve or gate-moving mechanism to operate, which operation requires time; and again, it requires time for gravity to overcome the inertia of the increased quantity of water that must pass through the wheel before an increase in power can be had. During all this time, the speed of plant has been decreasing if the load was increased, or increasing if the load was decreased, and the amount of change in speed depends entirely upon what ratio the change in load bears to the stored energy in the moving parts of the plant. A heavy change in load will of course cause a greater change in speed before the power supply is changed, than a light change in load. The problem is, therefore, to proportion properly the power storage to the changes of load that must be imposed upon the plant, because this power storage, or the capacity to store power, must take care of all changes in load until the power supply, or gravity effects, can compensate for said changes.

The second factor, "time required for gravity to generate power," is more constant than the first. In fact, the limits are established in the construction of the water-power plant, and, of course, remain so. The point we wish to emphasize most in the time requirements is the inertia and momentum effects of the water.

A locomotive can propel a train of cars at a rapid speed; but it takes time to acquire such speed. When the locomotive has brought enough pressure to bear upon the train, it moves, at first slowly, but keeps increasing in speed often many seconds before it reaches full motion. The locomotive may be limited in strength to 250 H. P. per second. The train in full motion may represent 25,000 H. P. for a second. In such case, it will take the locomotive 100 seconds to bring the train to speed if we do not consider the frictional losses. Water has no power in itself; but must be put in motion by gravity in the same manner that the locomotive starts the train of cars, and a long train of water acted upon by a constant gravity effect, is put in motion in the same manner that the train of cars is by the locomotive. It is plain, then, that the time element must be considered in the government of water-power. The water-wheel cannot furnish power until it brings to rest the water to which gravity has given motion, and it can receive no power from the water until the water has sufficient motion for the moving wheel to retard. It is also plain that there must be changes in the flow and velocity of water for every change made in the load of the water-wheel; also the change in the flow of water must occur before there can be a change in the power supply.

It is well known that water has practically no elasticity; hence, if enclosed in a long pipe, the whole body must be put in motion at the same time. If the pipe or flume consists of several hundred feet of horizontal length and only a few feet of vertical pipe or "head" which alone gives gravity effects on the wheel, it is a similar proposition to the locomotive and train of cars. It is very evident, then, that long horizontal pipes should be avoided in order to reduce to a minimum the time required to get gravity effects, because the speed of water-wheels will keep changing, after a change in load, until the effects from gravity can correct it in the power supply.

Gravity effects at best are very slow as compared with steam, and for this reason a water-power is handicapped in the matter of government. The logical conclusion is, that in water-powers the water or power supply should all be under the direct action of gravity and move in line with it. This reduces the time necessary to furnish increased or decreased power, to the shortest limit.

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EDITORIAL.

A FAVOR SOLICITED.

It is difficult to gauge the value of the service rendered to an advertiser by a periodical for the reason that its publisher has no means for determining the amount of business that an "ad." brings. The advertising pages of a paper hold the position of a solicitor for business, but the advertiser is the only party to the contract who has any facilities whatever for approximating the amount of business brought either directly or indirectly by any particular advertising medium, and even his facilities are closely restricted for it is not a rule that he knows the source from which an order is derived.

It is important to the advertiser that he learn the value of each advertising medium and it is of double importance to the publisher that his publication should receive the credit for any and all inquiries or orders given through his medium.

A very simple favor then is asked of all, viz., will you kindly mention "The Journal of Electricity" in writing to the advertisers in its pages.

It costs you nothing and it renders both advertiser and the proprietor a highly valued service.

A NOVEL ENDORSEMENT.

In these days of cleverest competition, the best man wins provided his prices are lowest and his qualities are highest, but rarely are these requisites combined in so novel a manner as occurred in the recent awarding of the contract for the electrical equipment for the Southern California Power Company. The installation is one of extraordinary note as this initial plant is to consist of four 1,000 horse power, 1,000-volt generators, feeding step-up transformers which deliver current to the line at 33,000 volts for transmission to Los Angeles, 81 miles distant.

The bidding was confined to three companies, one, of which the Stanley company, has made a specialty of the development and perfection of inductor generators. The buyer, who installed the first three phase plant in the country, has had long experience in transmission work, and steadfastly maintained the opinion he had formed of the superiority of the inductor type over rotating field generators, and the award was conceded to the Stanley company when the two remaining companies captured the prize by modifying their bids so as to install inductor type apparatus at the figures already submitted for less recent forms of equipments.

Thus did the Stanley company lose the contract, but it is doubtful if the pecuniary loss it suffers will not be returned to it a hundred fold by this, the most radical and far-reaching endorsement which any electrical company in America has ever been forced to give the ideas of a competitor.

THE BERLINER CONSOLATION.

The attention of a great portion of the electrical fraternity of the country is at present wrapped up in a consideration of the probable effects of the recent decision of the Supreme Court of the United States,, which held that Berliner did not obtain the notorious transmitter patent of November 17, 1891, by fraud. The decision observed that "a wisdom born after the event is the cheapest of all wisdom" and so, now that the court's findings have appeared, it is looked upon as a simple case and one upon which the court rendered a most righteous verdict, for without a particle of evidence, either direct or indirect, supporting the allegation, how could the charge of fraud be sustained?

It is simply justice that in every instance the burden of proof shall fall on the accuser, hence those who feel instinctively that fraud has been practiced by the American Bell Telephone Company, one way or another, in the matter of the Berliner patent, have no recourse at law but they are nevertheless privileged to their own opinions. These people too, and there are legions of them, intuitively feel that the whole affair which called forth the late Berliner decision, was a supposititious suit—that it was conceived in sin and born in iniquity; that the sin was that of artful machination and the iniquity, that of illegitimate profit. Of this there is of course no evidence extant, not a "scintilla" as the court has said, but many will, nevertheless, feel a moral conviction that assumptions long this line are well grounded.

The facts of the case are that the Court did not pass upon the question except the allegation of fraud in the issuance of the patent, hence its validity is yet undetermined. Moreover, the present attitude of the Bell Company seems to indicate that it proposes to prevent if possible. the adjudication of the validity of the Berliner patent, evidently fearing an adverse outcome and believing that the patent will render greater service as a bogy than as a bludgeon. The telephone

situation may be epitomized as a struggle between the popular bent and an astute corporation, wherein the former is simply battling for its right of existence. The expression "its right" is used as there is every reason to believe that the courts will nulify the patent, particularly because of the expiration of the English patent on January 8, 1894, as provided under Section 4887 of the revised Statutes.

A further evidence of the lameness of the Berliner patent is developing in the attitude of the only electrical periodical that has been charged with being the official organ of the American Bell Telephone Company, namely, "Electrical Engineering." This paper which has steadfastly sustained the monopoly and as steadfastly discouraged opposition enterprises, has, since the rendering of the Berliner decision, stooped to the vituperation of a leader of the independent telephone movement, Mr. James E. Keelyn, President of the Western Telephone Construction Company of Chicago. The decadence of "Electrical Engineering" from its original high plane of excellence in technical literature, to the indesputible bias and rancor of its present editorials on the telephone situation is lamentable, but it is not so noteworthy as is the evident extremity of the Bell Company, which thus finds personal abuse a weapon necessary to its warfare.

The decision of the highest tribunal in the land on the question of fraud has afforded a measure of consolation and solace to the Bell Company, but when the Court acts on the validity of the Berliner patent, then will come a winter of discontent for this most crafty of corporations.

ENGINEERING DIFFICULTIES IN CHINA.

That difficulties of practically an insuperable nature beset the introduction of many engineering enterprises in China is not doubted by those familiar with the situation in that far-off country and it is an oft-told tale that one of the greatest set-backs of this nature is the fanatical superstition of the natives who check if not actually prevent the erection of poles and wires because of the unholy shadows they cast. Each traveller knows of this superstition and vouches for the obstacles it presents, but as the devout Chinaman does not object to shadows falling on the earth provided it does not defile a spot under which moulds the bones of a departed friend or kinsman, there is a way out of the difficulty as the existence of telegraph and telephone companies shows.

The accursed custom which poles have of casting blighting shadows will probably not prove so great a barrier to the introduction of electric railway enterprises will the combined opposition of the telegraph and telephone companies which, owing to their priority, perpetrate a dog in the manger policy rather than reconstruct their systems so that disturbances from railway return circuits will be prevented. Transmission projects, too, will probably meet like opposition, and indeed the experiences have thus far been that the serious mention of a new electric railway enterprise in China brings from the companies named the intimidation that the installation of a railway or transmission or alternating current system will mean the giving up of the telephone and telegraphs, for, they say, it is impossible for both to be operated in the same territory. The citizens of enlightened countries wherein each city of importance contains practically every commercial application of electricity, each working without interference with the other, will recognize this as a rare specimen of corporate bosh, but it placates slow-going China and, in lulling it back to sleep, tolls the knell of another projected enterprise.

Assuming that an electric railway company, for instance, should sufficiently warm itself into the good favors of the numerous mandarins, who sway Chinese officialdom as best pleases their moods and purses, so that it could withstand the freeze-out sorties of the telegraph and telephone companies, and should, moreover, with ominpotent zeal, at last succeed in erecting its poles here and there so that the soul-blasting shadows from poles and wires ne'er could fall on grave or on house with sickness or prospective confinement, the ability thus far acquired might enable the building and operation of an electric road through the narrow tortuous rat-ways ycleped streets. In China, a two-foot passageway gives perfect satisfaction as an alley; if it have a width of six feet or so, it is dignified to a street, while ten feet is an avenue and twelve feet is a boulevard indeed. Considering the prejudice with which aristocricy the world over regards the defacement of its boulevards by the "unsightly" trolley, one must conclude that the railway system of a Chinese city will perforce, be relegated to its streets and avenues, where it would doubtless be beset by troubles distinctively its own. Then the density of the moving population that ceaselessly worms over each inch of every thoroughfare and the sacred funeral procession that insures the eternal happiness of the dead according to the measure of pomp and gorgeousness displayed, to the quality of the incense of burning sandal or odorous punk, to the quantity of smoking pig, of steaming rice and of garlicky chicken and to the volume of wail set up by the hired mourners! To obstruct the way of, or to cast a shadow upon, such a cortege would entail the eternal damnation of the dead and what could the poor street car man do?

Then again, human life is held in low esteem in China—except when the prospect of "blood money" exhorbitantly inflates its value. The sportsman who would shoot quail or snipe must look sharp lest his shot perforate the vitals of the mongol who rises as from the ground in front of the gun, courting death that his family may bleed the slayer for the life-long affluence of a settlement for five hundred dollars or so. With the "deadly trolley" abroad in the land of the Celestial, one may well stand aghast at the thought of the extent to which the mania for being

killed under its relentless wheels woud be developed there. Verily, the path of the street railway man in China is beset with entangling vines and vicious thorns and ragged rocks of unwieldly weights.

Some day the dawn of knowledge will break the blackness of the polar night that has ever enveloped China; then in the bright sunlight of civilization will awaken its millions upon millions of people and warm into life and usefulness its mighty, though dormant, resources. Until then, it does not appear that the Flowery Kingdom will hold forth any Utopian inducements either to foreign labor or to foreign capital.

Passing Comment

An Editorial Review of Current Events and Contemporary Publications.

SHALL PLANT COSTS CONFORM TO FUEL COSTS?

Power station engineers will not be slow to grasp the significance of the idea which led Mr. R. J. Hill, Chief Engineer of the Chicago City Railway, to install simple non-condensing engines, instead of compound or condensing engines, and rope transmission drives instead of direct connected generators in the new power house of that company. This is to be the largest electric plant of its kind in the country and is fully described in a late number of "Power", which points out that Mr. Hill, after a thorough canvass of other stations and a study of the results obtained, concluded that at the present relative prices of fuel and machinery, a better ultimate efficiency would result in this particular instance by adopting a plan of installation which, on its face, looks like ignoring the improvements and developments of the past decade.

Whether Mr. Hill's expectations of being able to run the plant at greater economy are to be realized remains to be seen but this much is certain that the mania for burdening a plant with high-priced machinery for the sole purpose of economizing low-priced fuel is liable to be carried to an unwarranted extreme. There is much to be said on the question, both pro and con, and the outcome will be awaited with unabated interest by the engineers of those communities blest with cheap coal, and should Mr. Hill be wrong in his convictions, which seems to be very improbable, he will nevertheless have won for himself enviable distinction as a deep-thinking engineer with rare courage to execute his bold convictions.

A MANUFACTURER'S RIGHTS UPHELD.

American manufacturers will feel more than usual interest in the decision recently rendered by an English court, under which the firm of Sugden, Pound & Wagner, former selling agents for the Magnolia Metal Company (of New York) in Europe, and which traded under the name of the Magnolia Anti-Friction Company of Great Britain by special permission of the parent company, has been dispossessed of the agency and, together with other persons and concerns, have been perpetually enjoined from continuing the fraudulent business of making an anti-friction metal and branding it with the trade mark of the Magnolia Metal Company of New York, imitating its ingots, marking the boxes in which the metal is packed: "Made in the United States," and otherwise deceiving and imposing upon purchasers of anti-friction metal in Great Britain and Europe. The appeal taken from the injunction referred to, was tried before the Court of Appeals, Lord Esher presiding, and the perpetual injunction granted by Justice Collins was confirmed. It was in this trial that Lord Esher denounced the action of the parties above named and characterized their performances as "a disgusting fraud."

The piracy which leads not only to the appropriation of a trade mark, but also to the wholesale manufacture and sale of a spurious product under convincing representations that it is the genuine material, cannot be too strongly condemned and now that the English Courts have declared that justice must prevail, the suits which have been brought by the Magnolia Metal Company in American Courts against infringers will give wholesome publicity to the wrongs that American manufacturers suffer at the hands of foreign as well as domestic competitors.

LIQUID AIR AND POWER TRANSMISSION.

That man is only upon the threshold of some of the sciences is evidenced by the points brought out by Mr. Edward A. Rix in the conclusion of a lecture delivered to the engineering students of the Leland Stanford, Junior, University on May 3rd last, and which is reproduced on another page of this number, concerning experiments with liquified air or "aerine," as the lecturer states it is to be called. The matter is best brought out in Mr. Rix's own words. After discussing the use of compressed air for mining purposes and attributing the commercial production of aerine to Mr. Charles E. Tripler of New York, more than twelve months ago, Mr. Rix proceeded to describe experiments recently made in his presence in New York as follows:

"I look upon the commercial production of aerine as a very important discovery, and I think the future question of economy in motive power is intimately associated with this liquid. Compressed air, at pressures ranging from 1,000 pounds upward, is conducted from an air receiver through a small pipe, is refrigerated to expel its moisture, and is then conducted into the apparatus which liquifies it completely, without the use of chemicals of any kind, and it flows from this apparatus in a stream about the size of a lead pencil (in the apparatus which I saw) into a glass insulated receptacle, containing about two gallons. I saw this

receptacle filled in a very short time. Of course, while in an open vessel aerine has no pressure, but its temperature is approximately—385 deg. Fahr. Inasmuch as it is boiling rapidly on the surface, owing to its absorption of heat from the atmosphere, it looks like carbonated milk on the surface, but upon dipping some of it out in a glass and observing its color through the glass, it has very much the appearance of ordinary water, and about the same weight. Its temperature is very deceptive, for as it runs from the condenser one may allow it to trickle over the fingers for a short space of time, and it appears to have the atmospheric temperature. The sensation is very much like pushing one's hand into a bag of feathers or into a mercury bath, allowing, of course, for the difference in weight between the mercury and the aerine. If, however, you immerse your hand in the liquid a sufficient time to establish a contact, the flesh would be burned, the same as if it were exposed to 440 degrees of heat, measured above the atmospheric temperature. If a test tube of $1\frac{1}{2}$ inches diameter, having a couple of pounds of mercury in the bottom, is immersed in aerine, the mercury will be frozen solid in a few seconds, and may be hammered out and otherwise manipulated the same as lead. An alcohol thermometer of large size will be frozen instantly upon being immersed in the liquid, while it will take several minutes to thaw out the small bulb of this thermometer by covering it with the palm of the hand.

"A tablespoonful of aerine poured on about a fluid ounce of whisky will freeze it at once into flat scales, giving the whole the appearance and color of cyanide of potassium. This may be emptied out on a table and will remain frozen in that condition for fully five minutes. A teacupful of aerine poured on top of a tank of cold water goes into its spheroid state instantly in globules of about half the size of ordinary marbles, which fly around on the surface, leaving a trail of white vapor behind them. A handkerchief saturated with the liquid will be charred and destroyed as if it were put in the oven and browned, though no change of color is apparent. Its evaporation is quite slow and it may be carried about for a number of hours in an open vessel without entirely disappearing. It probably represents a compression of about 700 atmospheres and would therefore, in a confined space and at 60 deg. temperature, represent a pressure of somewhere from ten to twelve thousand pounds to the square inch.

"Just what aerine has to do with thermo-dynamics I must leave to conjecture at present, for I am not permitted to say, but I know of some and look for many other remarkable developments. For transmission purposes there seems to be no reason why aerine should not be pumped through an insulated pipe, the same as water. When this becomes possible, the diameters of pipes to transmit large horse-powers would be exceedingly small. For instance, inasmuch as one pound of air will yield, in properly reheated engines, about 1.6 horse-power, a thousand horse-power would require 620 pounds of air or aerine per minute. This 620 pounds would occupy a space of but ten cubic feet. The transmission pipe, then, would have to convey ten cubic feet per minute. Let us say the transmission is for five miles. It is easy to calculate from ordinary hydraulic formulae that a three-inch pipe would convey this power with a pumping pressure at the point of supply of 200 pounds. The only pressure which the pipe would have to resist would be the pumping pressure, consequently ordinary gas pipe or tubing could be used, the cost of which, together with its insulation, would be an insignificant figure in comparison to the horse-power it would transmit."

Literature.

Any Book Published Mailed upon Receipt of Price by ***The Journal of Electricity.***

"A SYSTEMATIC TREATMENT ON ELECTRICAL MEASUREMENTS", by Herschel C. Parker, Ph. B., Tutor in Physics, Columbia University. Cloth $6\frac{3}{4}$ x $9\frac{3}{4}$ inches, 120 pages, 100 diagrammatic illustrations. Spon & Chamberlain, 12 Cortlandt St., New York, 1897. Price, $1.00.

The opening chapter of this handbook gives a classification of electrical measurements that suggests the scope of the work and sets forth the different methods available for the determination of any form of current or circuit value. It takes no cognizance at this place of instruments used, but instead presents a graphic scheme in classified form which shows at a glance the various modes for measuring all degrees of resistance, electromotive force, current, capacity, and inductance. This by no means, however, exhausts the store of information in this handy volume. Chapter II, for instance, treats of galvanometers and describes with ample illustrations the various forms of galvanometers in use, pointing out the special adaptability of each, and generally their peculiarities and defects. Chapters XXI and XXII give formulae for determining the efficiencies of cells, lamps, motors, transformers and dynamos and of deriving magnetic determinations of fields, intensity of magnetisation, permeability, hysteresis, magnetomotive force and reluctance.

Professor Parker's book is a work that grows upon one and it does not require a close examination of it to convince one of its great value to those who have occasion to make electrical measurements of almost whatever description. To instructor and student it is indispensible; the engineer will find it of great service for its readiness in furnishing any formula that may have been forgotten and the lack of which becomes an annoyance and an embarrassment. Similarly the central station electrician who has efficiency tests to make and insulation resistances to measure or the chief operator who has the resistance of lines and cables to derive or faults to locate, or the expert who must report with accuracy upon the internal resistance of batteries or of electrolytes—all these and many others will find Parker's Electrical Measurements to be a most complete and concise text-book.

The scheme of classification which pervades the work is excellent and the impression it makes is so fa-

orable that one wonders why similar modes of graphically portraying those branches of special knowledge having ramifications, as it were, are not in more general use. The advantages of this treatment are thoroughly understood by the author, who is Instructor of Electrical Measurements of Columbia College and who emphasizes the importance of an accurate knowledge of electrical measurement and points out the lack of uniformity which appear in many instances in the methods employed. "Indeed," he observes, "it almost seems as if there were two schools of electrical measurement. But this is probably due, to some extent at least, to the lack of a proper co-ordination and classification of the subject. New methods of practice have rapidly developed, and improved instruments are constantly coming into use, so that it is not strange if there be a little confusion.

"Thus we may find a text-book that is almost perfect as far as resistance work is concerned but deficient with regard to electromotive force or current, describing at length obsolete methods and entirely omitting many of the best ones. So that often the student may be compelled to consult a great number of standard works and supplement this by long personal observation to obtain even a fair comprehension of the practical methods. The subject, it seems to the writer, should be attacked in the most systematic manner and the classification thoroughly worked out. Indeed, classification and knowledge are very nearly synonymous terms, and what follows is offered as an example of such a method of treatment."

That the reader may more clearly understand what is meant by the author's scheme of classification, reference may be made at random to any electrical function, such as electromotive force. There are considered under this division: (1) Batteries and Direct Currents, (2) Alternating Currents, (3) Very High e. m. fs., (4) Very Low e. m. fs., (5) Calibration of Voltmeters, and (6) Standards of e. m. f. Take, for instance, the subject of Alternating Currents, when from the group it appears that there are four different methods of measuring the e. m. fs. of alternating currents, viz: by the electrometer, by the dynamometer, by the caloric voltmeter and by the attraction voltmeter. There are, of course, different varieties of electrometers, such as the quadrant, the multicellular and the low-reading electrometer, as well as Thomson's and Weston's electro-static voltmeters, all of which appear in the schedule and are fully described in the text. Above all, the language of the text is clear and comprehensible and every word counts.

But one feature of importance is noted wherein the book may be considered seriously remiss, and that is in the omission of methods for determinating the values of the functions of polyphase systems. Indeed, it appears that even single phase alternating currents have hardly been treated with sufficient fulness in that means for the derivation of only voltage and amperage are pointed out, leaving the student to infer that the wattage of an alternating circuit may be found in the product of the volts and amperes. That this is always the case will not be contended by any means and that subsequent editions will bring out these points is evident from the author's confession that the book is not a finished work, but when this has been done, there will have been removed the only feature in the way of an unqualified endorsement of Professor Parker's most valuable book.

Pneumatics

COMPRESSED AIR FOR MINING PURPOSES.*

By Edward A. Rix.

It was my intention when first invited to read a paper here on compressed air, to deal with the subject of "Power Transmission by Compressed Air," inasmuch as that particular theme is just now the subject of much speculation among engineers, and of much interest to power consumers, but upon reflection it appeared to me to be a better plan, and one which would help you the most, to discuss that use of compressed air which at present most vitally affects our own interests, namely, its use in our mines.

All of you, as engineers or spectators, in traveling through the mining counties of this State, will have occasion to observe the use and abuse of compressed air in many of its more important applications, and you will feel much more at home with the subject on such occasions after listening to a paper directed to that particular end than if a general subject, such as "Transmission," was dilated upon with no particular plant in this State to offer as an object lesson.

It is not my purpose to belittle the service which is rendered by that incomparable, mysterious power which we call electricity, although I may claim that it has usurped the legitimate place of compressed air in many instances. There is no conflict between these two great agencies. Each has its proper and legitimate field of usefulness, independent of the other, and it is easy for an intelligent engineer to recognize these separate rights, and in proportion as he does, so will his work be successful. A small portion of the territory of these powers seems to overlap and it is there that we hear the noise and confusion of disputed title, and many in the midst of this turmoil lose sight of the great independent domain of each which requires development and which will yield rich return to the earnest student and worker.

Compressed air is the only power which is alone sufficient to supply all the power needs of an average mine. For lighting purposes from five to ten per cent may, if required, be converted into electricity for that purposes. Where steam or water power is used, fifty per cent, or more, is converted into compressed air, and five to ten per cent into electricity for lighting. Where electricity is used, from fifty per cent to ninety per cent is converted into compressed air, the remainder being directly used for lighting.

The reason for so great a conversion of other powers into compressed air lies in the fact that generally one-half the entire power is absorbed by pumps, underground hoists and rock drills. The two former, in nineteen cases out of twenty, are actuated by compressed air, and the latter always. It is true that both the hoists and pumps may be run by electricity economically, but as yet there has not been produced a rock drill actuated by electricity which has been a success, and inasmuch as air is required for rock drills, and as they consume more than the pumps and hoist as a rule, the mine management generally concludes to use air for all three kinds of work rather than introduce two kinds of power service underground.

I am perfectly aware that my statement regarding the failure of electric rock drills may be disputed by manufacturers of the so-called article, or by electrical

* Lecture delivered to the engineering students of the Leland Stanford Junior University, May 3, 1897.

enthusiasts, but notwithstanding all that, I shall maintain my statement true, and it will receive the support of the larger electrical concerns.

It is true that electric drills have been made by two of three firms, and on the shop floor they drill very nicely, at the rate of two inches per minute, in medium granite, for the first two feet. From that point on to four and a half feet, the average depth of a blasting hole, their drilling capacity deteriorates very rapidly. The air drill does from three to four times this work easily.

The claim for the electric drill is that it consumes but one-third the power. This is true, but if it takes three of them to do the work of one air drill, the wages of six men will have to be balanced against the wages of two men and the extra power consumption. The latter equals, perhaps, the pay of one man, so that to do the same work with the electric drill would cost twice more than for the air drill.

There are other considerations, however, independent of this, which militate against the electric drill, namely, that it will not stand the dust, mud, water, hammer beating and general rough usage, and again, it would be necessav to introduce a ventilating system for fresh air, as well as to expel smoke, where electric drills are used, while with the air machines their exhaust furnishes all necessary fresh air and ventilation.

It needs no great discernment to see, therefore, that the simplest and most desirable proposition, and the one involving the least machinery and transformation of one power into the other, is compressed air, which exchanges from five to ten per cent of itself for lighting purposes only, while any of the others must make exchange for at least 50 per cent of air and the lighting besides.

I have assumed, of course, that the cost of any of these powers delivered to the mine was equal and the motors which absorbed them were the most efficient for the purpose.

All things being equal, then, I assume from what I have seen of the various requirements of a mine for power purposes, and for the reasons given before, that compressed air is the ideal power for general mining purposes. With varying conditions, however, it is simply a matter of combining and comparing the cost of fuel or water, repairs, interest on the plant, insurance and taxes, in order to select the proper general power, and should comparisons be nearly equal, then general utility, simplicity and safety, should decide the choice.

When the preponderance of evidence is for any one of these forms of power it requires no skill to make a selection, but when all things are equal as to cost and maintenance, or nearly so, in bringing any of the powers to the mine, then I wish to show why compressed air should be the choice without hesitation, and after the choice is thus made, how to use it so as to justify the choice.

Compressed air has been abused in its use most shamefully, and until recently none of its friends have been able to be seen or heard, so intensely has the interest of the world been centered upon the marvelous results of the investigation into electrical phenomena. The mysterious has such a fascination for the ordinary mind, and the meteoric developments of electrical science have followed so thick and fast, and in so many fields of usefulness, that the average individual could be stampeded into the electrical camp by a mere mention of the name of this most elusive fluid. Now there has come a breathing spell, and the advocates of compressed air are calling attention to the fact that compressed air, properly generated and applied, owns a place in the economics of the day, and this they propose to maintain.

Compressed air has been generally understood to be a most expensive form of power, and has been given sufferance only because of its utility, since for underground work it really has no rival at any price. Because the laws of compression and expansion of permanent gases belong to the realm of higher mathematics, few understood what they were dealing with, and many of these, unable to overcome the freezing of their motors, did as the public generally did, namely, used the air at practically full stroke, and threw away all the intrinsic energy of the air which we can develop by expansion. Theoretically they thus threw away two-thirds of their power, and practically about three-fourths. Ordinary direct-acting pumps and rock drills do not even have an efficiency of twenty-five per cent. No small wonder, then, that the wood piles have dwindled rapidly away and small power results been produced. Everything was sacrificed to utility, and compressed air did not take its proper rank until engineers began to realize that it must be used expansively. To use air in an ordinary direct-acting pump is equivalent to throttling a head of water to one-fourth of its spouting velocity to accommodate the speed of a wrongly geared water wheel.

I fancy that most of the trouble on the whole subject has arisen from a misconception of what compressed air is in a power sense. Many believe that the power of the engine which compresses the air has been stored in the air compressed, and the more steam they give the engine and the harder it worries and flurries, the more work the air should finally yield up. They cannot understand that a pound of compressed air at the same temperature contains the same intrinsic energy, no matter what the pressure is, and this is originally contained in the atmosphere before it is compressed at all. This being the case, no matter what power was expended to compress one pound of air to, say, 90 pounds gauge pressure, it will have at the same temperature but one intrinsic potential stored within it. Temperature is the head—if I may use a term applied to water—from it comes the power. If by reason of a physical condition, namely, pressure, one pound of air is allowed to fall from a height represented by a temperature, 60, to one lower, represented by say,—60, that one pound will generate 184.93 foot pounds of work through every degree it falls, and so on until it reaches—461, the absolute 0, which is the bottom where in theory air has neither pressure nor volume, and its work is done. The total intrinsic energy is always 184.93, multiplied by the number of degrees the one pound of air is distant from —461 deg. Fahr.

The center of earth is the absolute 0 of water power, for there water has no weight. This corresponds to the absolute 0 of air, and every pound of water at the same distance, measured in pressure, from the center of the earth, has the same potential, and independent of its temperature, just as one pound of air has the same potential at the same distance, measured in temperature, from its absolute 0, independent of its pressure. This 184.93 is simply the 778 which represents the foot pounds of work in one British thermal unit, multiplied by 0.2377, which is the specific heat of air at constant pressure—that is to say, it is the fraction of a B. T. U. necessary to raise one pound of air one degree. The quantity of heat therefore necessary to raise the temperature of one pound of air from absolute 0 to 60 deg. Fahr., which represents a distance of 521

degrees, will be 184.93 multiplied by 521, which would be 96,348.52 foot pounds, which represents the intrinsic energy of one pound of air at 60 deg. Fahr. This, of course, presumes that no heat will be either lost or gained by radiation or otherwise during the expansion of air, and this sort of expansion is called adiabatic.

The sea level for water corresponds to the atmospheric line for air, for at these points neither will manifest motion or power. Suppose the land and water to be on a level, we could not then use any of the potential in the water, unless by some mechanical device we continually created a shaft, whose depth we would call pressure, below the sea level, for the water to fall into and generate power, and it matters not how much power it requires to maintain this shaft at any depth, one pound of water dropping into it will always yield up the same fraction of its total intrinsic potential. The same with air—at the atmospheric line we cannot avail ourselves of its potential, so we use a mechanical device, called a compressor, to prepare a shaft, as it were, which we also call pressure, whose depth we measure in degrees of temperature, and no matter how much power it takes to maintain this condition of affairs, one pound of air dropping into this shaft will always give out the same fraction of its total intrinsic energy.

I hope I have made the idea clear that I wished to convey, namely, that in neither case did the resultant power depend for its measure upon the mechanical means which caused its activity. Consequently, in compressing air the energy stored in the compressed air is not a definite function of the power required to compress it, but is a definite function of an ideal compression we call isothermal, with an empirical index determined by practice.

In order to show you, by some calculations, that the intrinsic energy in the air is independent of its pressure, and that no matter between what points of pressure you expand the air, there will always be enough power in the air left to account for its total intrinsic energy, namely, 96,348.52 foot pounds, at 60 deg. Fahr. This will show you at the same time why we depend upon the pressure to put the air in a condition to realize a portion of its intrinsic energy for work.

Taking, for instance, one pound of air at 100 pounds gauge, and at 60 deg. Fahr., if allowed to expand adiabatically to atmospheric pressure, it will produce work and consequently lose part of its heat, and we find that its temperature, after the expansion has taken place, is:

$$-173.96^{\circ}\text{ Fahr. or } T = To \left(\frac{P}{Po}\right)^{\frac{y-1}{y}}$$

The drop of temperaturo is $173.95 + 60 = 233.95$ degrees, and as $778 \times 0.2377 = 184.93$, the work of adiabatic expansion is:

184.93x233.95 = ... 43,264,37 foot pounds

this being the useful work. The adiabatic work of expansion from —173.95 deg. Fahr. to the absolute 0 would be

184.93x287.05= .... 53,084.15 foot pounds

Total .... 96,348.52 foot pounds,

which is the total intrinsic energy—that is to say, we have utilized 45 per cent of the total intrinsic energy.

Next, taking air at 10 pounds gauge, the temperature after adiabatic expansion to atmospheric pressure is —12.9 deg. Fahr., and the useful work of expansion is:

184.93x72.9 .... 13,481.39 foot pounds.

The adiabatic expansion from —12.9 degrees to absolute 0 would give

184.93x448.1= .... 82,867.13 foot pounds

Total .... 96,348.52 foot pounds,

i. e., the total intrinsic energy, and the useful work is here 14 per cent of the total intrinsic energy.

It is hardly necessary to say that these figures are theoretical, because, in practice, part of the work of expansion, and consequently part of the heat, is absorbed by the friction of the piston in the cylinder, and lost by radiation from the various pieces of the machines.

We see, therefore, that the only portion of the intrinsic energy of air that is practically obtainable is the expansion work which it does above atmospheric pressure, i. e., that the pressure of this air must be raised above the pressure of the atmosphere.

I have spoken only of the energy stored in the air after it is compressed. There is, however, a perfectly mechanical translation of energy from the prime mover to the air motor, that we call the energy of full pressure and is that part of the work performed in an air compressor or given out in a motor which takes place at constant temperature, or, in other words, is the work performed by the piston to discharge the air from the cylinder. I might call it an air piston rod, which reaches from the compressor to the motor, and conveys the energy of one to the other absolutely mechanically and in the case of isothermal compression would act just the same as if a column of water reached from the compressor piston to the motor piston. It is nothing but a flexible piston rod, acting during the period of full pressure only, and stops when the compressor stops, unless the air receiver be infinite in its capacity. It is this air piston rod only, which direct-acting pumps and ordinary motors and rock drills use, thus availing themselves of a mere mechanical phase incident to the operation of a compressor and abandoning entirely the real work which is stored in the compressed air itself, and which is practically three times the value of the other. It would be just as sensible to judge the economy of a steam engine by its full pressure work only, as to do so in an air engine.

I have been thus explicit on this somewhat puzzling point because I wish it well understood that the least possible power expended in compression gives the highest resultant efficiency and is the first condition precedent to an economical air plant. You are all no doubt familiar with the way to produce this, namely, highest form of prime motor, compound compression where proper minimum frictions in all moving parts, slow piston speeds, least clearances, large valve areas and cooling surfaces, so that heat of compression shall be as nearly constant and at initial temperature as possible, or, in other words, isothermal. It is always, you perceive, a case of temperatures.

Now, in using the air after compression, or, in other words, to utilize as much of its intrinsic energy as possible, we become involved in a case of temperatures again, and it is precisely the reverse in all ways and considerations of the phenomena of compression. If it be true that difference of temperature between the admission and exhaust of the air in a compressor is the head to be overcome by the prime mover in reaching a certain receiver pressure, it is evident this difference should be made as small as posible, and reversing the case for air motors it is evident it should be made as large as possible. Everything would tend toward the accomplishment of this fact readily, were it not for the

presence of moisture in the air, which while it offers no difficulty to compression, which is a heat-developing phenomenon, freezes at once during expansion, which is a cold-producing phenomenon. This freezing has nothing to do theoretically with the perfect operation of the air in its expansion, but practically it fills up the valve ports with ice, congeals the lubricants, and the motor stops. These temperatures range often as low as —150 degrees.

Inasmuch as it matters not between what degrees of temperature we do our expansion, so long as we maintain the same difference, it must occur to the engineer at once that if, in expanding from atmospheric temperature downward, he meets with the mechanical obstruction of ice, he must slide his range of temperatures up the scale until the final exhaust temperature shall be such that ice will not form. Inasmuch as this cannot be done without supplying extraneous heat, either before or during expansion, the idea of reheating is at once suggested, and upon it hinges the whole subject of the economical use of compressed air.

In determining the amount of heat to be applied to the air before use, it will be found that no great temperatures are required, averaging generally about 150 deg. Fahr. to exhaust at 32 deg. Fahr., and give complete expansion to atmosphere.

Inasmuch as every degree we add to the temperature of the air before use increases its head, provided we exhaust always at the same temperature, and inasmuch as lubricants will not be destroyed at 400 deg. Fahr., or even more, it comes as a natural conclusion that while we are reheating we should go to the practical limit, and especially as it is found by experience that the additional fuel required is of little consequence.

The increase of power obtained by this increase of volume (for that is the way the increased temperature manifests itself) ranges from 0 to 60 per cent. at an expenditure for fuel which, after reducton to terms of the prime mover power, means an addition of from zero to ten per cent of that power, depending upon the head and price of water, or price of fuel. A gain of fifty per cent at an expenditure of ten per cent may in some cases be made to cover all losses of compression and transmission, and deliver to the motor the full amount of power expended upon the air at the compressor, or even more.

It need not be demonstrated here that the use of fuel to expand air is from five to seven times more economical than it can be used in any other manner to generate power.

Having thus shown you the proper and natural conditions under which to compress and to use air after it is compressed, and having also called your attention to the requirements of a modern air compressor, the motor is the last thing and the most important thing to be considered. It appears to me that inventors and builders of compressed air machinery are devoting too much time to the compressor and none at all to the special air motor. Compressors can be made having an efficiency approximating ninety per cent, while the average motor using the air from such a compressor would not give forty per cent.

To those who care to put thought on the subject of compressed air I would suggest the subject of special motors and reheaters, as a field offering both honor and remuneration. The advocates of compressed air would gain several points if they would pattern after the methods of electrical engineers, who have claimed from the very beginning that nothing was too good in the shape of material or machinery for the development of electrical power. The very finest and most efficient prime motors are always insisted upon, even down to insignificant plants, and the splendid construction of generators and installation of machinery and appurtenances, scarcely without regard to cost, has enabled them to place their product upon a high engineering plane. Their methods and their ideas for the advancement of their interests have been correct, and they are justly entitled to a commensurate reward.

How all this contrasts with the miserable class of compressed air machinery which until the last twelve months has been installed throughout the country. The very cheapest of slide valve engines, or some jumping, flapping belt for prime movers; poorly designed, poorly made compressors, with insufficient valve areas and cooling devices; generous clearances; enormous piston speeds; all and everything done to make a machine as cheap and undesirable as possible. For motors, anything that would reciprocate, the valve motions causing the pistons to meter out nicely the air in solid chunks at full pressure; the real work being done at the end of the exhaust pipe, and I might add that the louder the noise of escape the more work was supposed to be done in the cylinder, whereas in reality the air was simply making a louder protest at its misuse.

All this must change, and is changing, and an awakening is at hand. It is the duty of every pneumatic engineer to insist upon high-class installations, not only for his personal success, but for the advancement of compressed air, that most willing, useful and satisfactory power medium ever given to the service of mankind.

(To be continued.)

Correspondence.

The Journal of Electricity is not Responsible for Opinions Expressed by Correspondents.

INSULATORS FOR HIGHER POTENTIALS.

To the Editor:

Sir:—I have read with interest the leading article in the May number of the Journal upon the Riverside transmission and also note in the same issue the editorial regarding insulators for extremely high potential use, in which you state that the only thing lacking to transmit very high potential is a perfect insulator.

I would like to say that in my opinion it is not very difficult to make an insulator of sufficient strength, mechanically and electrically, to meet the requirements, but a commercial difficulty stands in the way in the matter of cost. With the principle involved in my new two-part insulators, I can make them to carry any potential that it is practicable to use, but the cost involved in the manufacture of such insulators is considerable and on long transmission lines it will make the insulation cost so much that it is sometimes impracticable to use them because the power may be worth no more after being transmitted 100 miles than though it were transmitted 10 miles.

I have the insulator to meet the requirements and am working hard every minute to reduce the cost of manufacture to allow its adoption for all classes of work.

FRED M. LOCKE.

Victor, N. Y.

Fraternal.

THE ELECTRIC TRANSMISSION ASSOCIATION.

A meeting was held at the offices of the Blue Lakes Water Company in the Crocker building, San Francisco, on June 11th to effect the organization of the Pacific Coast Electric Transmission Association. The companies represented at the meeting were the Blue Lakes Water Company of San Francisco, the Big Creek Power Company of Santa Cruz, the Southern California Power Company of Redlands, the Central California Electric Company and the Sacramento Electric, Gas and Railway Company of Sacramento, the San Joaquin Electric Company of Fresno, the Power Development Company of Bakersfield, the Portland General Electric Company of Portland, Or., the Nevada County Electric Power Company of Nevada City and the San Gabriel Electric Company of Los Angeles.

An organization was definitely settled, with the objects of mutual protection and the collection and dissemination of information relative to the generation, transmission and distribution of electrical energy. The officers elected were: President, C. P. Gilbert, manager of the Sacramento Electric, Gas and Railway Company; Vice-President, H. H. Sinclair, manager of the Southern California Power Company; Secretary and Treasurer, Robert McF. Doble, Secretary of the Blue Lakes Water Company; Executive Committee, W. Frank Pierce, President of the Blue Lakes Water Company, and J. J. Seymour, President of the San Joaquin Electric Company.

The annual meetings of the association will be held in San Francisco, while other meetings will be held at intervals at the various power stations throughout the Coast, when papers will be prepared and read on topics of interest in matters electrical, the different methods adopted at the different plants for obtaining particular results, etc.

At the first meeting there was an informal discussion in regard to insulators. The same subject will be taken up and discussed formally at the next meeting, which is to be held at Santa Cruz about the middle of August.

The association will not accept as members any dealers in electrical or other supplies, or the representative of any manufacturer.

THE GOOD TIMES ARE HERE.

That the California Electrical Works is fast forging to the front in the race for supremacy of the electrical business of the coast is evident from the number of big contracts it secured during the month of April. Among these are the installation of iron armored conduit systems in the Claus Spreckels and Spring Valley Water Co.'s Buildings, and the closing of yearly contracts for the supply of Buckeye incandescent lamps to be used exclusively by the Pacific Mail Steamship Co., the Southern Pacific Co., the Market Street Railway Co., and the Pacific Improvement Company. The considerations for those contracts alone reach tens of thousands of dollars. Among the smaller business transacted may be named the sale of Warren alternators, a 60 k. w. machine, going to Anaheim, Cal., and a 30 k. w. machine to Porterville.

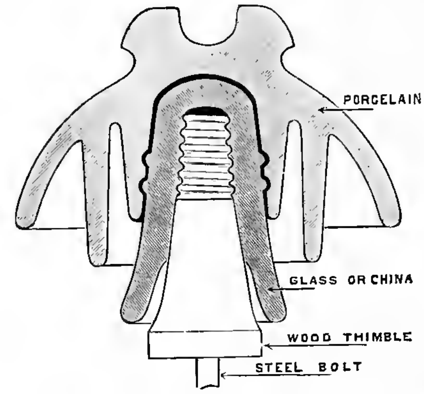
Industrial.

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

HIGH POTENTIAL INSULATORS.

In no department of engineering has it been so fully or so frequently demonstrated that good work and good material pay as in the field of electrical applications of power. Cheap devices, like cheap labor, mean a constantly increasing repair account, the reduction of which unnecessarily large item of expense means dividends to the operating company. Moreover no feature in electrical transmission is more essential to absolute permanance and reliability of operation than the line and to perfect the materials used in line construction has been the untiring effort of Mr. Fred M. Locke, of Victor, N. Y., for years past.

The latest of Mr. Locke's production is the extremely high potential insulator shown in outline in the accompanying cut. It is a two-part insulator designed to carry potentials up to 50,000 volts, and is made in different sizes according to the current carried. It has an outer shell of Chinaware on account of its high insulating surface and its mechanical and electrical strength, and has a center insulator of glass as shown in the accompanying sectional view, to further insulate it and to prevent puncture by the high potential current. It is also made of two or more shells of china ware, the advantage of this over one solid insulator being that the shells being made separately ½ inch thick, each allows more uniformity in making and more through vitrifaction, than could be obtained otherwise in one solid insulator 1 inch thick. Besides this are secured four thicknesses of glazing from the



SECTIONAL VIEW OF THE LOCKE EXTREMELY HIGH POTENTIAL INSULATOR.

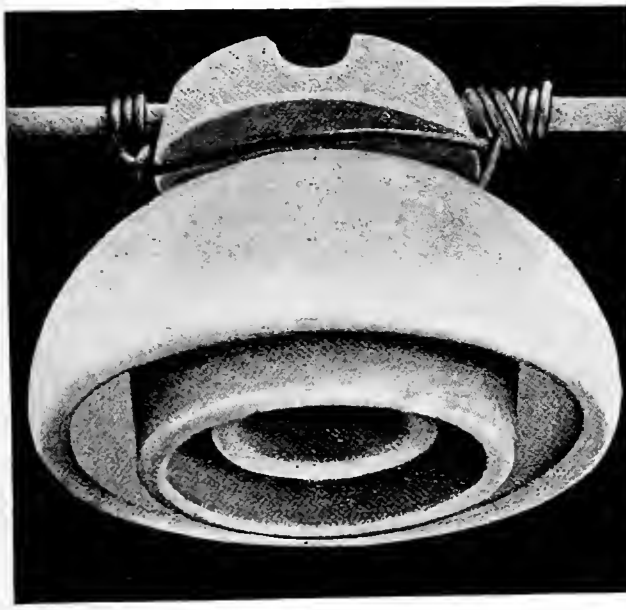
two shells, which further increases its insulating qualities.

By repeated practical tests it has been found that a potential of 100,000 volts will not puncture the insulator; hence it will carry with safety and economy any voltage that is practicable for use in commercial application of electric power.

The body and glaze of all the Locke insulators are of simple earths only, fused together into a vitreous, homogeneous mass at the greatest heat. No lead or other metallic oxide being used in making, and the glaze is not a conductor. The body and glaze being of exactly the same material and fired at the same heat the insulating qualities are as high without as with the glaze.

These Insulators will not craze or crackle on the surface or "leak" as insulators made of inferior material will do when subjected to variations of temperature. The ware used in their construction will stand severe tensile strains or heavy blows without injury, and will not crack or chip from the effects of high potential currents.

Heat, cold, dampness, acids, alkalies cannot act to disintegrate or otherwise injuriously affect the properties of them, as their structure resists the action of gaseous and fluid substances as well as of other forces.



THE LOCKE TRANSMISSION INSULATOR.

No other insulator possesses, or maintains to such a high degree, all the essential qualities of high insulation resistance here being the best, it is the cheapest.

The Locke pin is made especially for the heavy work and good insulation required in the highest potential transmissions. The belt has a diameter of $\frac{1}{2}$ inch and has a wood top of five inches above the arm with a $2\frac{1}{2}$ inch base. It is boiled in paraffine, making it water-proof and a good insulator. The art of preparing the wood so it will absorb the paraffine is not generally known. In some instances when wood pins were supposed to be boiled in paraffine, a test showed them to be of little benefit; but if the pin is properly treated, it can be made to show a high resistance for years. The wood on these pins is properly treated. All Locke pins are made for standard cross-arms, but can be had for any size arm.

Mr. John Martin, is handling the Locke line materials as Pacific Coast agent, in conjunction with the agency of the Stanley Electric and Manufacturing Company, with offices and warerooms at 300 California street, corner of Battery street, San Francisco.

WALKER ALTERNATOR.

In designing the Walker Alternator, of which a cut is presented in the advertising pages, the Walker Company has endeavored to conform to the general outlines which have become familiar to the public during the last few years, as distinguishing the Walker Generators. The single casting, including base and end bearings, the ample self-oiling bearings, the copious oil wells, the interior motor and the horizontally divided external ring, correspond in general appearance to the other types of Walker apparatus.

The machine is of the type known as an "Inductor Alternator." In adopting this type, the Walker Company has followed its usual practice of not exploiting new and untried types of machinery, but of adopting a type which has been in existence sufficiently long for its principles to be thoroughly familiar to the manufacturer, and its marked advantages as well known to the public. Some advantages distinguishing this type in general, and this machine in particular, may be seen from a study of the different parts of the generator.

A solid iron casting is keyed to the rotating shaft. The hub, together with the outwardly projecting arms or spokes with laminated iron tips, forms part of the magnet circuit.There are no windings upon this rotor, no insulation to chafe or jar loose, no sliding contacts offering continual opportunity for trouble. The function of the rotor is (1st) to provide a path for the magnetic field, and (2d) as part of the magnetic circuit, to vary the position of the magnetic flux, relative to the armature coils.

To the interior of the fixed ring, shown in the cut, are secured annular laminations. These armature laminations are furnished with inwardly projecting teeth and support the armature coils. There are twice as many armature coils as there are inductor projections, and at any instant half the coils lie opposite these, and half opposite the spaces between the inductors. The armature lying external as it does to the inductor gives room for ample cross section of conducting wire, without infringing on the space necessary for insulation. The coils, themselves, are thoroughly insulated in the process of construction; and again, the sides and bottom of the slots are lined with composite insulation of the best materials before receiving the coils. Thus the insulation between armature windings and frame is of the highest quality, and being upon the stationary portion of the machine, is not exposed to the slow disintegration which deteriorates some varieties of insulation upon revolving armatures.

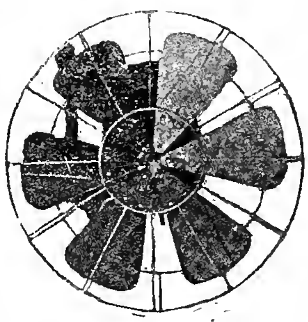
The inductor and armature together form a discoidal box, the stationary armature ring being the periphery. One side is closed by the projecting arms of the inductor; the other by a casting continuous with the armature ring, and extending radially inwards, leaving only the necessary clearance between it and the inductor hub. Within this annular box, concentric with the shaft and securely bolted to the armature casting, is the coil supplying the excitation necessary for the machine. The magnetic lines generated by this coil, starting from the armature ring, flow inwards along the side of the armature casting, across the air-gap into the inductor hub, out along the inductor arms and through the laminated tips, across the air-gap into the amature teeth; the changing position of the inductor arms supplies the variation of magnetic flux through the armature coils necessary to produce the required voltage.

A further advantage of this machine is the accessibility of different parts for repair. The planed surfaces of the base allow the armature to be slid parallel to the shaft far enough for inspection and minor repairs to the armature coils and field. If it should be necessary to dismantle the machine, the operation is simple The field coil is unbolted from the armature casting

and supported by the inductor. The top half of the armature is removed and the operation is completed by lifting out inductor and field coil together.

A WATER-MOTOR FAN.

The Brooks-Follis Electric Co., always on the lookout for something new and attractive, are now placing a fan motor on the market to be operated by water. In many places the electrical current is not available in the day time for fan motor use, but water is most always easily obtained.



The Cox Water-Motor and Fan is designed and constructed on mechanical and scientific principles by one of the best mechanics in this country. It is simple, durable and neat of construction, consisting of three parts only, the wheel, case and back, all of the best quality, and by quality is meant the best of material, skilled workmanship and rigid inspection. The case and back are of cast iron. The bearings each are 1 1-8 inches long and made of brass. The vanes of the wheel are also of brass, and therefore will not rust out.

It is very economical in operation and consumption of water, consuming one-third less than any other motor on the market, and can be operated on a pressure of thirty-five to one hundred pounds. By using two jets of 1-16 of an inch and less, according to water pressure, each jet alternating with the other in striking the outer edge of the vane thereby, there is obtained a very rapid, steady and noiseless motion, producing a very powerful breeze.

The entire outfit is a "thing of beauty and a joy forever," and an ornament wherever placed. It is as easily installed as an electric fan, connecting with any convenient water pipe or hydrant, and is guaranteed not to leak. It is just the thing for counters, offices and stores, or any place where a fan is desired.

As electrical current is not always procurable, the Brooks-Follis Electric Co., is raising the "wind" in more ways than one, as anyone can easily see by stepping into their office and seeing their display of Water and Electric Fan Motors. They are carrying the Westinghouse, Lundell, Emerson and the Hunter-Detenrk Fan Motors, in addition to the Cox Water Motor. It will pay anyone contemplating putting in a Fan Motor to investigate their line.

The Brooks-Follis company is also placing an arc lamp on the market that is meeting with a ready sale. The lamp is of the long burning type, burning 150 hours without retrimming. It gives 450 candle power and consumes only 200 watts per hour, and is but 20 inches over all, being finished in polished brass. Either for direct or alternating current. Send for further information.

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Elec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.): The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

The Journal of Electricity

Vol. IV. JULY, 1897. No. 4

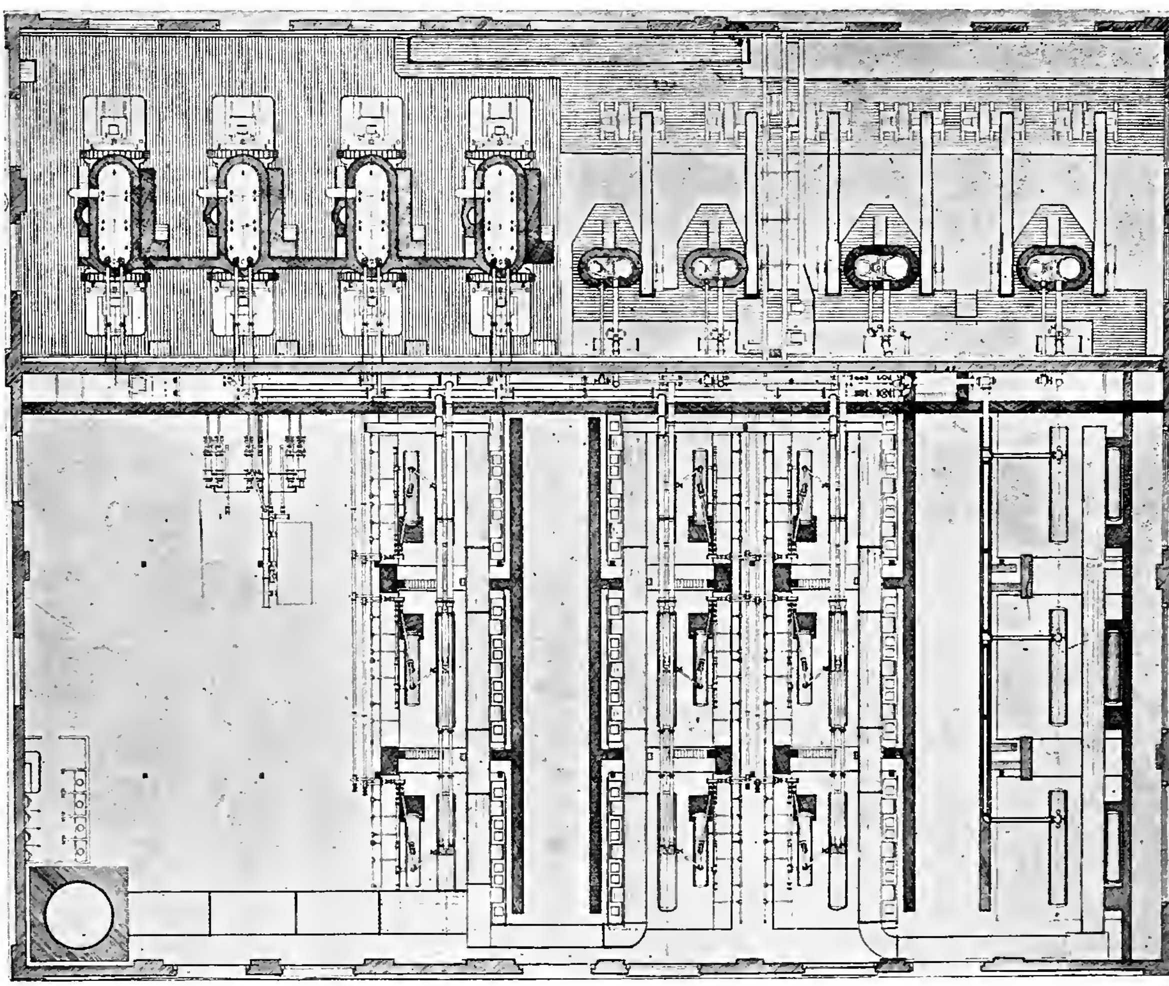
The Bryant Street Power House.

By W. W. HANSCOM, M. E., E. E.

The General Power House of the Market Street Raiway Company is located on the block bounded by Bryant, Alameda, York and Channel Streets, San Francisco.

During the year 1893 grading was commenced on the present site and the following year saw a brick building with a frontage of 165 feet on Bryant street, extending half-way back to York street and ending in a wooden partition which was to be removed when demands required an additional power house space. The fire room fronts on Channel street, alongside the steam railroad track, and convenient for coal supply, while the engine room, separated from it by a 24-inch brick wall, fronts on Alameda street. This location is in about the center of the car district and is well situated for supplying the new districts now being built up.

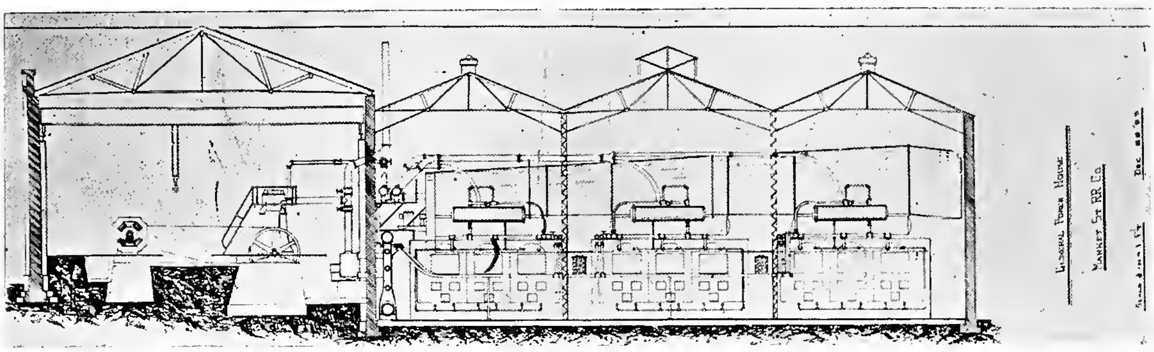
The plant as originally laid out consisted of four Union Iron Works compound engines, two being of 300 horse-power and two of 600 horse-power, belted to six General Electric 200 kilowatt multipolar compound wound generators and nine "Elephant" horizontal return tubular boilers designed for 130 lbs. working pressure and set in batteries of three, arranged for hand firing with natural draft. Early in September of '94 the plant was started, but owing to the non-



GROUND PLAN OF THE BRYANT STREET POWER HOUSE.

completion of the pumping station, which was to supply condensing water, the engines were run non-condensing until the following April, 1895.

In the meantime during the construction of the power plant, the old horse car line on Mission street had been reconstructed into a modern overhead trolley electric system and power was first supplied to operate the cars on this road. Third, Kentucky, Fillmore, Bryant and Solano streets soon followed, and later on, Kearney, Broadway, and Fourth streets and tributaries. The Metropolitan Electric System was operated from a separate power house on Carl street, but was later supplied from the Bryant street power house and the Carl street station was then shut down. The increased demand for power soon necessitated an increase in the supply and orders were placed with the Union Iron Works for a 1300 horse-power direct-connected, triple expansion unit with the necessary boilers, etc., together with a switch board of sufficient capacity for contemplated and future developments. The boilers were three in number, of the same type as the first, but differently fitted, and the board was commenced at both ends and gradualy filled in toward the center, the circuits being changed from the old one as fast as the new one was installed. The new unit was not connected in common with the old belted ones immediately, but was run on separate circuits during the heavy load period and shut down at night when the load was light enough to be carried by the smaller engines. The new unit operated with steam at 160 lbs. working pressure. An overhead electric traveling crane was also installed and later, three more similar units were ordered and installed, and a tool room and workshop were fitted up in a corner of the fire room handy to and opening into the engine room.



ELEVATION OF BRYANT STREET POWER HOUSE.—BOILER ROOM SIDE.

The present plant consists of nine boilers in batteries of three, each being 64 inches diameter by 16 feet long, designed for 130 lbs. working pressure and fitted with the United States rocking grate bar, and operated under natural draft with hand stoking; also,

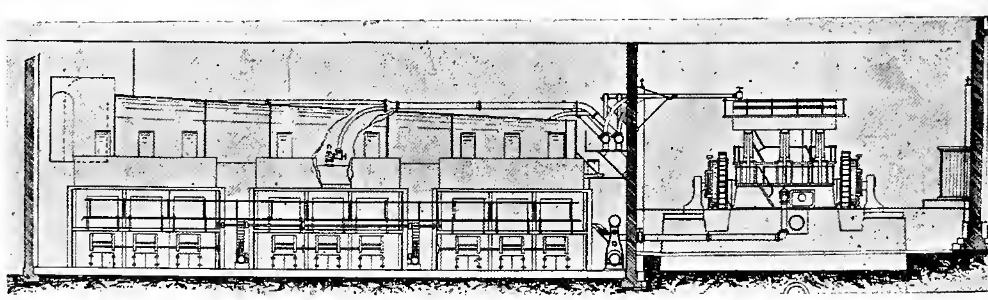
27 boilers, each being 64 inches diameter by 16 feet long, arranged as the above, in a row of three batteries of three boilers, and being designed for 160 lbs. working pressure and equipped with Roney mechanical stokers and Howden forced draft system.

Two 300 horse-power compound condensing engines, cylinders 16-28 inches by 24 inches stroke, 160 revolutions per minute, with cranks 180 degrees apart, and

Two 600 horse-power compound condensing engines, cylinders $22\frac{1}{2}$x39x24 inches stroke, 160 revolutions per minute, with cranks 180 degrees apart.

The smaller engines have one and the larger engines have two fly wheels, each 9 feet in diameter, with 25 inch face and weighing 12,000 lbs. each. Each fly wheel is belted to the pulley of its generator by a 24 inch double leather endless belt. One of these engines (600 horse-power) is shown in accompanying illustration. Each engine is equipped with an independent condenser and air pumps, the circulating water being supplied under a sufficient head for circulating purposes. Steam is furnished each engine from a large receiver and its admission into the high pressure cylinder is governed by a shaft governor of the Ide type, the cut off on the low pressure cylinder being fixed. Both cylinders are steam jacketed.

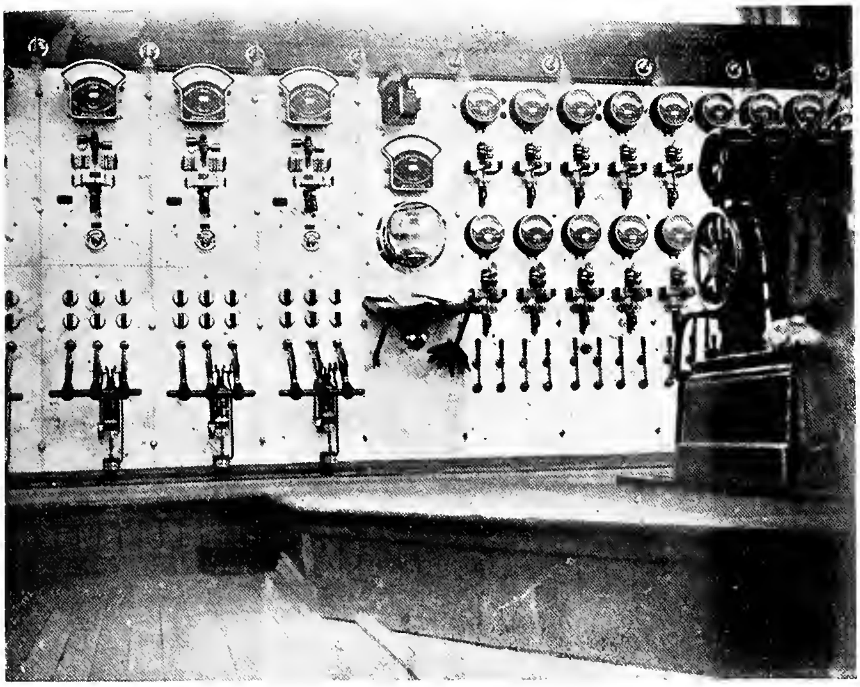
Four 1300 horse-power triple expansion engines, with cylinders 20-30-44 by 30 inch stroke, running at 150 revolutions per minute. As in the compound engines, the steam entering the high pressure cylinder is regulated by a shaft governor, the cut off in the intermediate and low pressure cylinders being fixed. The outside steam receiver is replaced by one embodied in the high pressure cylinder casting and acting as a jacket to the cylinder. The throttle valve is connected to both mains through stops alongside on top of high pressure cylinder. All cylinders and covers are steam jacketed and the valves are fitted with balance pistons on continuations of the valve stems.



ELEVATION OF BRYANT STREET POWER HOUSE—SIEMENS-HALSKE END.

The air pumps on these engines are driven from the intermediate cross heads by rocker arms and the condensers are a part of the bed plates and have the circulating water outside the tubes in contact with the bed plate, insuring a minimum amount of heating in the journals. All bearings and slides are arranged for water circulation, the supply being taken from the

injector by a donkey pump, and the discharge from each bearing, etc., is in plain view from the back of the engine. The top platforms are connected by flying bridges with each other, making a continuous path for the oiler from one engine to the other. The cranks are at 120 degrees and the large diameter of the Siemens & Halske armatures renders the use of fly wheels unnecessary.



CENTER PANELS OF THE SWITCHBOARD.

The bearings throughout are fitted with wick oil feeds, as in marine work, the reservoirs supplying a number of bearings depending on their location. Each reservoir receives oil from a common supply pipe leading from the main supply tank under the engine room floor. The drips are caught in pits and led to the filter system alongside the supply tank, and when purified are pumped into it under an air pressure of from 15 to 20 pounds. The entire arrangement is very economical, but 50 gallons of oil being used per month in the eight engines.

Circulating water is supplied by a pumping station situated alongside the bay on Kentucky street and connected to power house by 6000 feet of 36 inch cast iron pipe. In the station are two centrifugal pumps, each belted to a 150 horse-power General Electric motor, 500 volts, receiving current from the power house and controlled by rheostats in the field and armature circuits. But one of these is required at a time. A stand pipe in the pump house regulates the supply pressure and takes care of the surge in the pipe. The water is supplied under a pressure of about 15 lbs.

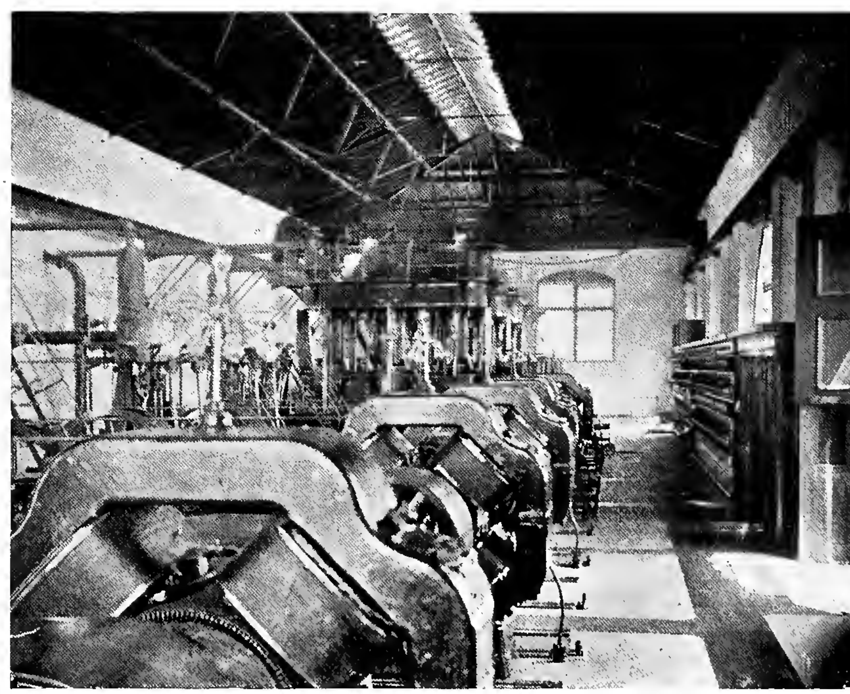
At the power house the discharge is carried into the street sewer by a system of pipes and valves acting as a siphon and relieving the pumps of some of their duty. One of the small engines at the power house is started on the atmosphere in the morning to start the pump motor. The salt water is also used by the water cars for sprinkling the road beds, and a connection with switch valves permits of the fire pump drawing salt water from either the supply or discharge at the power house.

The pumping station is operated on a ground return with an auxiliary wire so connected at the power house as to be inside the circuit breakers and fused at the pump station as to be disconnected from the ground and used as a return in case of the main breakers going out.

The generating equipment consists of:

Six 200 kilowatt General Electric multipolar compound wound railway generators, 500-590 volts, running at 480 revolutions per minute. These are belted to the compound engines, one to each 300 horse-power and two to each 600 horse-power.

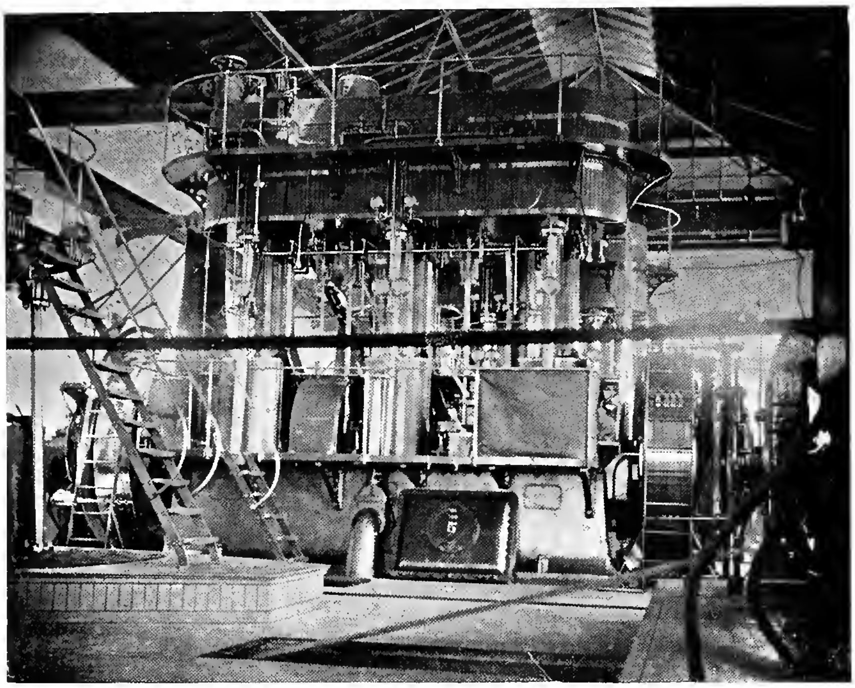
Eight 400 kilowatt Siemens & Halske 6 pole, external armature generators (500 to 590 volts, at 150 revolutions), are directly connected to crank shafts of the 1300 horse-power engines, one on each end. They are connected to the same bars and in multiple with the General Electric generators, the necessary adjustments on all machines being made by shunts across the positive and equalizer wires at back of switchboard, so that the load is evenly divided amongst the machines in proportion to their capacities.



A GENERAL VIEW OF THE GENERATING ROOM.

The leads from dynamos to the switchboard are taken down through the engine room floor, into large conduits, thence along and up the back of the board to the terminals.

The switchboard, which is designed for a maximum output of 10,000 amperes, is of white California marble, 2 inches thick, and mined from the quarries of the Inyo Marble Company. It is 59 feet long by 8 feet high and is set 5 feet away from the wall and in the center of the length of the station. There are 29 panels, each being two feet wide, the fourteen to the left of the center being connected to the generators, and the fourteen to the right, to the feeder circuits. The center panel is fitted with Weston illuminated dial ammeters and voltmeters, the latter on a swinging bracket, the former being connected in the bus bar between generators and feeders. A Thomson recording wattmeter and log desk complete this panel. Each generator panel has mounted upon its face an illuminated dial Weston ammeter, a Westinghouse circuit breaker, a shunt field rheostat, a cut-in voltmeter plug, a triple-pole main switch, and a Siemens & Halske carbon shunt field switch, which opens the shunt circuit gradually through a pair of carbon points, slowly separated by means of a worm wheel and crank. The generators being of different sizes, the scales on the ammeters are so graduated as to indicate a correct distributon of load when the needles occupy the same angular position.



A 1300 H. P. UNION IRON WORKS AND SIEMENS-HALSKE SET.

Each of the feeder panels is arranged to supply four circuits, each of 400 amperes, having a round dial Weston ammeter, Westinghouse circuit breaker and single-pole switch for each circuit. The top and ends of the board are finished off with polished teak molding, the lamps for illuminating the board being fastened to the top molding. The feeder wires lead from the bottom terminals of the switches through the floor and along the conduit underneath to the end of building, thence up and out. A test of the regulation of the four compound engines made on August 30, 1895, for ten minutes, with four counters, one on each engine, all being started and stopped simultaneously by an electrical attachment, showed as follows:

Engine No. 1—600- horse-power, load varying from 300 to 690 amperes, 1589 revolutions.

Engine No. 2—600 horse-power, load varying from 300 to 690 amperes, 1589 revolutions.

Engine No. 3—300 horse-power, load varying from 150 to 345 amperes, 1592 revolutions..

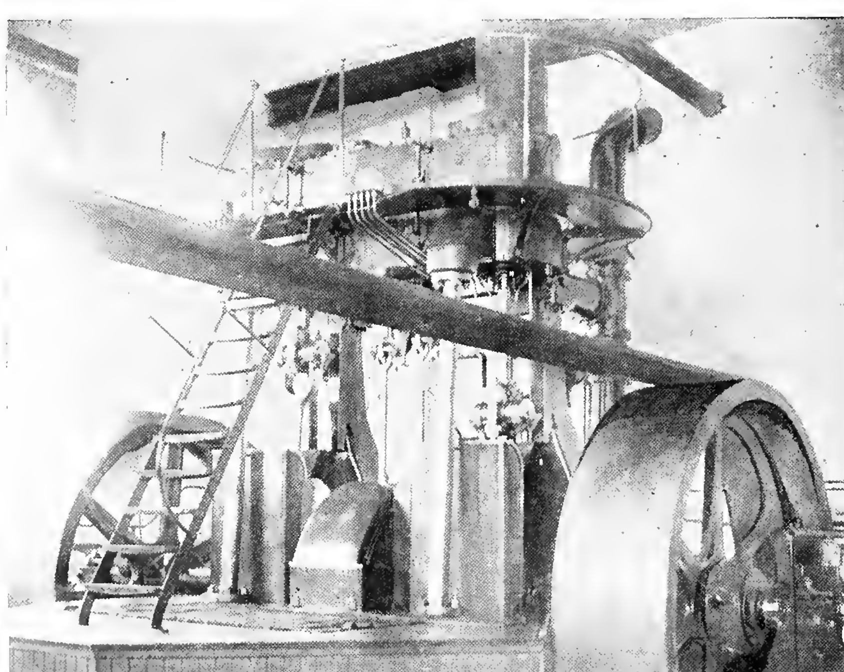
Engine No. 4—300 horse-power, with generator excited only, throttle wide open, 1594 revolutions.

The steam pressure during this test was 30 lbs., the vacuum being 126 inches.

The maximum current of the station at present reaches 6000 amperes and the average for 21 hours is 2200 amperes.

BICYCLISTS, BEWARE!

The State Supreme Court has held, in the case of Everett vs. the Los Angeles Consolidated Electric Railway Co. (34 Lawyers' Reports, Annotated 350, that a person riding between the rails of an electric railway upon a bicycle is chargeable with the duty of looking out for and endeavoring to avoid danger from the electric cars; and the motorman seeing him is entitled to assume up to the last moment that the rider will turn out of the way by increasing his speed or turning aside to avoid the danger.



A 600 H. P. UNION IRON WORKS ENGINE DRIVING TWO GENERAL ELECTRIC GENERATORS.

Pneumatics

COMPRESSED AIR FOR MINING PURPOSES.*

By Edward A. Rix.

(Continued from Page 54.)

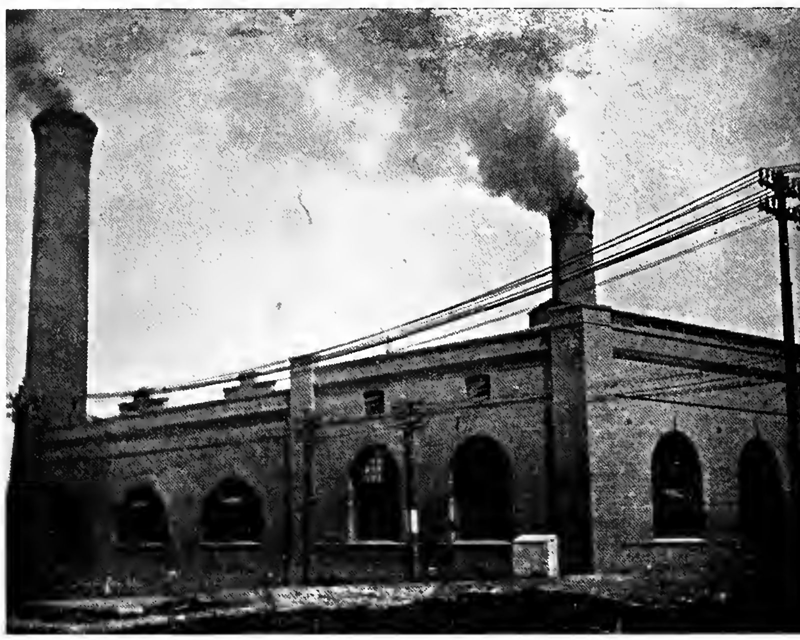
The requirements of the ordinary mine in this State, as far as power is concerned, may be enumerated as follows: Power for hoisting, for both surface and underground pumps, for rock drills, for milling and for lighting, for forge blasts and the mine whistle, which must be provided for some way, as it serves to mark the shift changes and give the fire or accident alarm.

I will take up each of these heads, briefly; speak of the prevailing practice here, and how it can be improved; and in any comparisons I may make between the efficiency of compressed air and any other power, I shall assume that the horse-power in each kind of power costs the same, ready to deliver to the various motors.

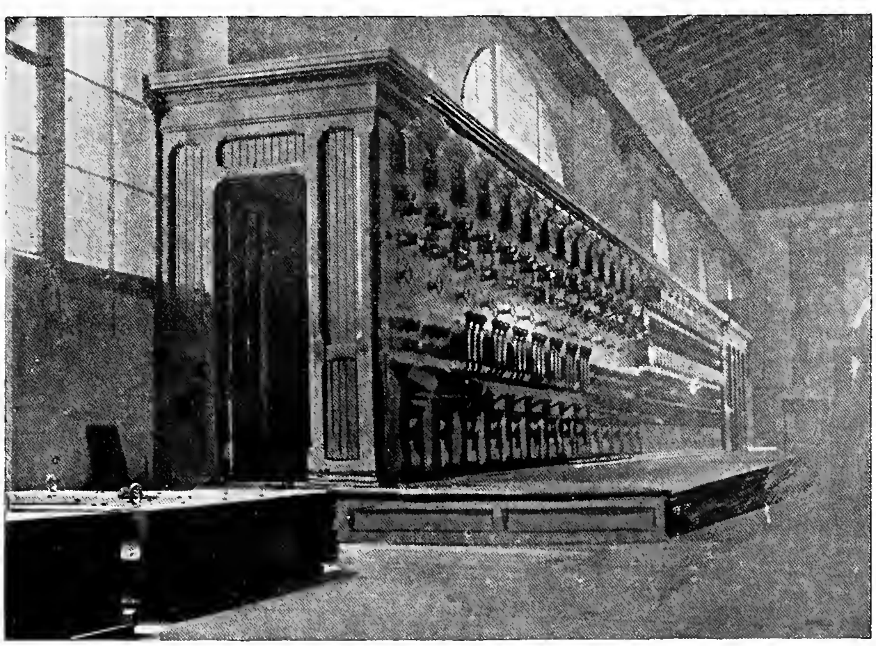
Before speaking of the various motors to develop the required power, we shall assume that our mine is properly equipped with conduits and reheating apparatus. Too much stress cannot be laid upon the fact that generous air conduits on the surface and underground, properly provided with bends or elbows of large radius and properly insulated where they convey hot air, contribute greatly to the economical operation of an air plant.

While the actual loss to the compressed air in its potential, by the drop in pressure, caused by friction in small pipes, is not more than one-third of what the public believes it to be, still the annoyance in not getting initial pressure where small working cylinders are used, is great; and again, the increased velocity in small pipes down a shaft deprives the compressed air of a gain instead of a loss of power as it goes downward, which it would have in proper sized conduits.

Illustrating the first point, it is generally assumed, for instance, if a compressed air pipe receives air at 100 pounds and delivers it at 80 pounds, that the loss is twenty per cent. So it is, in pressure; but relative pressures do not measure such a loss, for while the pressure has decreased, the volume has correspondingly increased, and the real loss is merely a frictional one of 8.4 per cent instead of twenty.



The Bryant Street Power House.



General View of Switchboard.

Illustrating the second point, there is a very material gain to be had from the weight of air in average shafts, provided the pipes are of proper size. Air at 90 pounds gauge on the surface would be 92 pounds at 500 feet, 94 pounds at 1,000, 96 at 1,500, and 98 at 2,000 feet—a gain sufficient to offset all frictions and ordinary leakage, a proportion which cannot be matched in electrical transmission down a shaft.

Most of the air plants in our mines are inefficiently piped, and no attention whatever is paid to long bends, and the pipes in general appear to be specially installed to exhibit every class and variety of pipe fitting the market affords, and with many duplicates. I have counted five 1-inch elbows in the space of three feet to connect up a pump to the main air pipe, when the price of 1-inch hose and couplings would have been less and the hose would have delivered to the pump nearly the line pressure. The pressure loss in each of the 1-inch elbows would be (.005V2-3) five-thousandths of the square of the velocity of the air through

* Lecture delivered to the engineering students of the Leland Stanford Junior University, May 3, 1897.

the pipe. The pump had a six-inch cylinder and the piston moved fifty feet per minute. The ratio of the cylinder area to the pipe being 1 to 36, the air in the pipe must move 1,800 feet per minute, or 30 feet per second. This squared and multiplied by five one-thousandths makes a loss of $4\frac{1}{2}$ pounds for each elbow, or 22 pounds for the five, certainly not a sensible or desirable result, yet one sees it everywhere in the mines. The passion miners have for 1-inch pipe is marvelous. One may frequently see strings of it five hundred feet long, conveying air. It has cheapness and ease of installment to recommend it, but the wood pile and the owner suffer. A proper plant should have no 1-inch air pipe underground over ten feet long, and no short elbows.

At some convenient place, where the total length of air conduits from the surface motors shall be a minimum, a good reheater should be established and connected to all these motors. There is ample scope to improve upon the reheaters now upon the market. They may be classed as coil, tube and shell reheaters. The former a simple or nest of coils within a furnace; the tube reheater consisting of a nest of pipes screwed into a cast-iron head, and all surrounded by a furnace; the shell reheater made much like an ordinary domestic sheet-iron heater, except that it will sustain pressure, the fire being within it.

Any of these will do fairly well, especially if well insulated on the outside to prevent surface radiation. They should be provided, in large plants, with pyrometer and proper dampers, to prevent overheating. We build also a compound reheater, which contains two independent heating compartments for different pressures, the utility of which will be seen later on.

A very small amount of fuel will be used in one of these reheaters—just about half a cord of pine wood a day, to reheat 100 horse-power of cold air so that it will yield 140 horse-power. When it is remembered that one-half a cord of pine wood will yield at the maximum 8 horse-power for twenty-four hours, when burned under a steam boiler, its capacity to produce 40 horse-power is a little short of incredible. Besides doing this, it renders still further service by permitting us to use the compressed air in an expansion engine.

Some engineers use a steam boiler for a reheater, especially if it is already installed at the mine. A slow fire is maintaned on the grates, and about eighty to ninety pounds steam pressure maintained; the compressed air bubbles up through the hot water and mingles with the steam. Fully ninety per cent of the mixture is air. This system has earnest advocates who claim that the latent heat of the condensing steam being released in the motor cylinder just where it is then ended, and the condensed water acting as a lubricant, makes this system preferable. It is certain that the heat can be carried farther this way, but we lean to the classes of dry reheaters mentioned first because they are simpler, will give higher temperatures, and require less fuel.

A temperature of 450 deg. Fahr. can easily be maintained in the dry reheater, and with well insulated pipes this will insure 400 deg. Fahr. to all motors contained within the ordinary hoisting works with mill adjoining.

There should be installed, at the end of the compressed air transmission pipe, ample reservoir capacity. This is, next to reheating, the most important feature in a compressed air plant for mining work, and it is in the proper arrangement of this particular feature that we make a great gain in economy over electrical power for intermittent work.

The two sets of machines which take the most power around a mine are the rock drills and the hoists. These use large powers for short periods, and frequently the average power covering twenty-four hours is, in the case of the hoist, from one-third to one-fourth the maximum, and with rick drills about one-half, where more than three machines are in use. It is evident, therefore, that if sufficient storage capacity be provided, the average power will only be demanded from the transmission main, while in an electrical plant the maximum power must be continually delivered by the transmission, for it may be required at any moment. This makes it an expensive proposition to use electricity for intermittent work.

True, storage batteries would accomplish the desired end, but who dares face their first cost and cost of maintenance.

As an instance of the relation of storage to intermittent work I will cite the case of the Banner Mine, at Oroville, California, that has a compressor having a single double-acting $10\frac{1}{2}$ by 12 inch air cylinder; the piston makes 300 feet per minute, and the machine is probably delivering 150 cubic feet of free air per minute. This size of machine is rated by builders as a two-drill compressor, yet it is driving two $3\frac{1}{8}$-inch machines, one $3\frac{1}{2}$-inch, one $2\frac{3}{4}$-inch, and, on occasion, a 2-inch also. The united requirements of these machines, should they be running at the same time, would be 285 cubic feet per minute—almost double the output of the compressor. The explanation lies in a very large and unnusual reservoir capacity—in fact, ten times larger than ordinarily employed with a compressor of that size. The wisdom and economy, however, of such large receiver capacity is apparent, and this example should be followed, especially as receivers are very expensive.

As an example of the advantage of reservoir capacity with a hoist, I call attention to the hoist at the North Star Mine, Grass Valley, which develops 80 to 90 horse-power when running, but calls on the compressors to exert but from 25 to 30 horse-power to maintain it. There are probably not five mines in the State with proper air reservoir capacity, and if it were possible to arrange contracts with the mine owners to yield up fifty per cent of the saving effected by putting in proper pipes and receivers, more than one person could earn a comfortable income by making such changes in this State alone.

Receivers should be placed at any general distributing point in the mine, as well as upon the surface. Anyone managing a mine, by keeping a record of two days only, of the length of time his intermittent machines are running during the day, can readily calculate the proper receiver capacity required.

Coming now to the machinery proper for the mine, first in order of installation is the hoisting works, which we will consider only from the standpoint of economy and utility. It is supposed, of course, that the elements of strength, safety, capacity and everything, have all been properly considered by whoever was the designing engineer. It is almost a rule that a mine that can afford to have an economical transmission plant has use for a hoist of sufficient capacity to enable it to be one of the highest motor type, and for this purpose I should install a compound hoist, direct-connected—that is to say, there will be no gear-

ing whatever on the hoist, the shaft carrying the drums being at the same time the engine shaft. The cylinders proportioned with reference to the initial and final pressures desired, and also with respect to the amount of expansion done by reheating. To get the largest amount of work from a hoist of this character the air should be reheated to about 400 degress before passing into the initial cylindtr. It will be exhausted from there back into the second compartment of the compound reheater, and heated again to 400 degrees; from there it will pass to the low pressure cylinder, perform its work and be exhausted to the atmospheric pressure.

It does not require any particular amount of calculation to show that with this double reheating the volume of the air may be practically increased from sixty to eighty per cent, with a corresponding degree of economy.

For the second reheating there is practically no extra fuel required, the second reheater being placed above the first one and absorbing the heat after it has passed through the first series of tubes. The piping on a plant of this kind should be so arranged that either cylinder can take the high pressure air, for either cylinder exhausts it directly into the atmosphere, as well as the piping for the operation of compounding.

A hoist of this character will be found much easier to care for than one operated by steam, for there will be no condensed water to be carried off, and the machine is ready to start in operation at a second's notice. There is no other manipulation, as far as the motive power is concerned, except the opening of the throttle valve.

In the operation of a hoist of this character the service of storage reservoirs in conjunction with compressed air service becomes very apparent, and, as stated before, a hoist which requires from 80 to 100 horse-power to operate while it is in service would in the average mine require but 25 to 30 horse-power at constant work delivered by the compressor. The advantage of this is apparent, and while it is approached by steam power, cannot be matched by any other service excepting by a water wheel plant having large reservoir capacity.

And for the reason which I have heretofore stated, it is evidently the very worst proposition for the economical use of electricity, and the greater the proportion of the entire power used by the mine, that is devoted to an electric hoist, the poorer will be the efficiency of the whole system, for the maximum amount of power required by the hoist must be purchased and brought to the hoist motor ready for consumption at any time. Of course, this loss will be obviated whenever storage batteries become possible for everyday use.

The next surface motor of importance around a mine will be the mill engine, which as a general rule has a constant load. It is only in the smaller mills that the power required for the rock breaker is intermittent, but in such a plant as we have been considering, the rock breakers will probably be of such size that they can run continuously from the ore bins, which will render the total power required from the mill engine a constant.

In this case for compressed air the engine will probably be, for ordinary purposes, a straight-running simple Corliss engine, using reheated air. If the mill requires a considerable power, it would be advisable to install a tandem compound Corliss engine, where the air will be reheated twice, as in the case of the hoisting engine.

Compressed air can claim no particular advantage over electricity in its economy for driving this constant load, nor, for that matter, over a high efficiency water wheel or a compound condensing steam engine. The honors are practically easy all along the line.

Our general system being compressed air, therefore, there is no loss or disadvantage in using it for the constant load. The same course of reasoning will apply to engines which may be used for driving Cornish pumps from the surface, or any other constant load requirement, such as driving fans or tramways. For intermittent work, such as a sawmill, in connection with a mine, compressed air would have the same economy with a properly designed motor as for the hoist.

Outside of the requirements heretofore mentioned, the only other required service would be for furnishing lights. For an ordinary mine 10 to 15 horse-power would readily supply this. Compressed air, of course, will have to be transformed, through an air motor and dynamo, into electricity for furnishing lights, and this naturally must be at considerable loss, and of course in this instance furnishing the electric current direct would be very much more economical, but the amount of power required for this service is so insignificant, in reference to the balance required by the mine, that it need not be seriously considered.

For underground work there are practically but three kinds of work required—hoisting from winzes, running of rock drills and pumping.

Owing to the fact that, as a general rule, it is not desirable to place large or expensive hoisting plants under ground, the character of the engines used is not very economical,, but the work is so intermittent in its character—much more so, as a general rule, than the hoist on the surface—that even these uneconomical engines can be operated with compressed air for much less than by electricity. In many cases it is desirable to reheat this air, which can be done with perfect ease, either by means of an externally fired furnace, using either wood or coal, where an old shaft or a proper system of ventilation will take away the gases of combustion, or the air may be heated by an internally fired furnace, in which coke is placed at proper intervals of time in sealed chambers made to withstand the air pressure, and through which the compressed air passes, furnishing oxygen for the combustion.

It is always well in installing underground hoists of all kinds, to place in close proximity as large a reservoir capacity as possible.

For underground pumping, ordinary direct-acting steam pumps, using air for actuating them, are the most uneconomical machines that can possibly be employed in the use of any power, and should never be used, unless their utility more than counter-balances their wastefulness of power. In sinking pumps, especially in confined spaces, there is scarcely any other form of pump that can be used with any degree of satisfaction, and utility is the only thing to be considered. A power-driven pump would be undesirable under such circumstances. For larger spaces, compound direct-acting pumps for sinking pumps, and even station pumps, have a reasonable degree of economy, but would at the same time require an element of utility to be considered in order to counterbalance the economy of an electrically driven station pump. The latter,

however, possesses so many disadvantages in the fact that gears are nearly always introduced for the reduction of speed and are subjected to tremendous wear, that their use is limited.

For a properly operated mine, having a considerable quantity of water to pump, a station pump, with compound engines using reheated air, will give the greatest economy. When it comes to the subject of rock-drilling, which forms, as a general rule two-thirds of the power required underground, at present compressed air has the field all to itself, and here utility alone is considered, for rock drills are as uneconomical in the use of air as a direct-acting steam pump; still they do such a tremendous amount of work in comparison to the cost for operating them that their economy is measured only in the amount of rock or ore which they are instrumental in extracting, and not in the power which is required to drive them. It is evident, however, that it will take less power to furnish air for these machines if such air is taken directly from the transmission main than if it were furnished at the surface by water-power or electrical or steam motor. Besides, a considerable portion of the cost of furnishing compressed air to these machines is offset by the pure air which is furnished to the miners under ground and the readiness with which it blows the smoke caused by blasting from the various underground workings. For underground work it is also valuable in case of accident. Many an air pipe leading back into a drift, a portion of which has caved and imprisoned miners beyond, has not only furnished them pure air but at the same time these pipes have given a means of communication with those outside.

The use of air around a mine is also in the nature of an insurance, especially where a mine has the apparatus for using steam. Air being used practically under similar conditions to steam, can be utilized in the motor or engines, and, in case anything should happen to the pneumatic system, it will only take a few hours to close off the proper valves, fill the boilers with water, get up steam and proceed as before; whereas it is impossible to use the electrical apparatus with anything but electricity.

As far as first cost is concerned, the average of a number of costs of installation which have come to my knowledge show me that the air plant is from twenty-five to fifty per cent cheaper, depending upon the nature of the installation, the size of the power and the distance of the transmission.

As a general rule, the ordinary free gold milling mine in the State of California on a working basis would require motive power, divided up nearly as follows: 25 per cent for the mill, 32 per cent for the hoisting, 5 per cent for direct-acting pumps, 10 per cent for station pumps, 23 per cent for rock drills, and about 5 per cent for lights.

Allowing that electricity to the amount of this 100 per cent has to be purchased to operate this mine, using compressed air according to the manner that I have mentioned, I believe that there would be required about 74 per cent in comparison to the electrical requirement, divided up as follows: 25 per cent for the mill, 10 per cent for the hoist, 3 per cent for the direct-acting mill, 13 per cent for the station pumps, 16 per cent for the rock drills, and 7 per cent for the lights, making a total of 74 per cent.

My opinions in the matter are somewhat borne out by the experience of electrical engineers, themselves. For instance, in an article written in a pamphlet called "Stone," the following remark is made:

"You may not know that Mr. Thomas A. Edison, the greatest electrician of the present time, has been for the last two or three years experimenting on a mammoth scale, at Ogden, New Jersey, in which he quarries a low grade of iron ore, hoists and conveys the same by means of two cableways, delivers to the crusher, and after being crushed the material is gradually reduced to a powder, when by electrical process the particles are separated from the particles of stone, the iron particles being then compressed in the form of bricks and sold as a high-grade iron ore.

"Mr. Edison's quarrying operations involve the use of hoisting engines, drills, pumps, etc. Mr. Edison tried the Edison drill, which he told the writer he never saw until it was delivered to his quarry. The electric drill is being thrown out and the steam drill employed, though electric motors are still used somewhat in the mill. On all their hoisting apparatus steam hoisting engines are employed. Now, it seems that until Mr. Edison can successfully use electricity in quarrying operations, it is useless for others to waste their time experimenting in this line. For anything like intermittent hoisting with a derrick, the electric hoist is not nearly so economical or efficient as steam hoisting engines."

It has been found recently at Jerome Park, where a very excellent compressed air plant has been installed by an Eastern compressed air engineering concern, that they are operating hoisting engines and rock drills very much cheaper by compressed air than they formerly did by steam.

Statements are made, which I have no means of verifying, that it is done with one-half the coal formerly required when steam was used direct. The contractor is making a large excavation, covering probably a square mile in extent, for a reservoir. He has established in the center of the work a 500 horse-power air compressor, and is driving fourteen hoisting engines and fourteen rock drills at various parts of the work, and reheating the air prior to its use in the hoisting engines. The economy of this plant is so marked that at the present time a contractor in Philadelphia is installing a similar plant for work to be performed there.

These results seem to point to the fact that where steam, directly generated, cannot compete with compressed air it is useless for any other power to try to do so under the same conditions. It all lies in the fact that the work is intermittent and that is the principal claim made on this present occasion, that in determining the character of the power to be selected for any kind of an operation many things besides the efficiency are to be considered. Very frequently a compressed of the apparatus at full load and constant operation, air or water-power plant, capable of storage capacity, would be more economical to use at a constant load efficiency of fifty per cent than any other power at a constant load efficiency of ninety per cent. It is like the cost of a manufactured article—it matters very little what the rate of wages paid, provided the amount of wages which enters into the cost of the product be satisfactory. So it is in a power proposition—it is not the efficiency of five minutes' operation, it is the total cost covering twenty-four hours.

From an engineering standpoint, if one were asked the most economical steam motor to operate an electric steam railway plant, one would say, a compound

or triple expansion Corliss engine, running condensing. But this depends entirely upon the cost of the coal, for it has been proved in parts of the United States where coal is as cheap as $1 per ton, that the difference in interest and depreciation between the condensing plant and the simple high-pressure plant will more than offset the difference in the cost of fuel, even if the coal cost $1.40 a ton. This is an instance where high efficiency engines are not engines of great economy, and I have been particularly emphatic upon this point, because compressed air has suffered much on account of improper comparison with electricity, in this manner.

We all know that there have been constructed electric generators and motors that will give an efficiency of from ninety-two to ninety-five per cent at full load, while compressed air generators and motors fall below these figures in mechanical efficiency, but in practical economy for such work as we have had in consideration, I claim twenty-five per cent superiority in economy over the electrical installation. Mechanical operations are not conducted for amusement but for profit, and that operation which produces equal results with another, for a less monthly or yearly cost, labor, material, fuel or power, interest, depreciation, etc., being all given their proper value, is the more economical.

I claim that comprssed air, for intermittent work (which is fully fifty per cent of all work done by motors), has no rival for general economy or utility, and particularly is this true for mining work. It must always be borne in mind that economy in compressed air depends upon reheating, and then expansion, and my remarks are not directed toward that class of compresed air motors which use cold air or air at full pressure. Utility very frequently overbalances considerations of economy or efficiency, as may be illustrated in air brakes which are attached to the locomotives throughout the world. These air brakes are most uneconomical in the use of steam, using it practically at full pressure, and are about the same class of motors as the direct-acting pumps which have an efficiency of only about twenty per cent as compared to a high-class steam motor. I have heard it stated that there are 20,000 of these air-brake motors working in the United States alone, absorbing about 10 horse-power each, making 200,000 horse-power devoted to this appliance alone, which completely overshadows all the rest of the compressed air installations in this country in magnitude, and yet no one hears of anyone attempting to replace this very inefficient motor with any other more efficient appliance for generating compressed air, for its utility is such and there is so much dependent upon it, that economy is a secondary consideration.

At the present time in the Eastern States there is a very marked revival of interest in compressed air, with reference to its application to street-car motors. A considerable amount of money has been expended in experiments by two companies in New York City during the last year, which has resulted so favorably for compressed air motors that many street railway companies throughout the United States are preparing to make experiments on their roads in order to determine the relative merits for their particular purposes of compressed air as against the cable or electricity.

Within the last month a car has been running in the streets of Washington, D. C., but I have not had any reports from it as yet. About this time the most elaborate experiment of all, namely, the running of a train drawn by a compressed air motor, will start from Rector street, New York City, and run to Fifty-eighth street, on the Sixth avenue elevated road, at regular intervals. A 250 horse-power plant has been installed at a convenient point near one of the terminals, and every precaution has been taken to insure the successful termination of this trial. This plant will undoubtedly be open to public inspection, so that all may satisfy themselves.

The struggle between the electric and the compressed air systems for supremacy will not, as I have indicated before, be based upon the efficiency of engines or motors, but upon the general economy of the plant. This can be readily appreciated when we consider actual figures in connection with the operations of these plants. For instance, in a recently published report of the operating expenses of twenty electric roads in Connecticut for 1896, the average cost of motive power and line repairs per car-mile was 3 cents. The compressed air system, with coal at $2.75 per ton, water at $1 per thousand cubic feet, or waste, the labor, repairs and maintenance of power plant, depreciation and interest on the cost of the entire power plant, makes the cost per car-mile, of the motive power, $0.023. In either of these plants the cost of coal per car-mile does not exceed $0.005, or an average of about one-fifth of the cost of the motive power, so that one can readily see that engines and motors of even medium economy would not affect the cost of the motive power to any perceptible extent, provided that the cost of maintenance was low—in fact, maintenance is the principal expense in the motive power department, and what everybody is looking for at present is a system which places the cost of maintenance at the very lowest point.

My remarks become less true as the price of fuel increases, until, of course, there would come a point when the price of fuel would be the principal consideration. I should judge that on this coast we were about midway between these two factors.

MACHINERY IN TALL BUILDINGS.

American enterprise in the erection of big buildings for business purposes has become known the world over, and for the engineer these piles of stone and metal hold varied and important interests. From the beginning of their foundations his services are indispensible, and after completion the maze of machinery which they hold continues to require them, for advice as well as management. Like the modern ocean steamship, the large business building of the present day harbors, deep down, out of sight of all but the operating force, a magazine of power of which the proportions are but vaguely guessed at by the multitude above. Boilers, engines, dynamos and pumps there are in bewildering numbers, supplying heat, light and power to the upper regions through miles of pipe and wire; humming blowers and exhaust fans both supply and abstract air through many-branched ducts for ventilation purposes, and ice and refrigerating machines, too, often must have a place, all helping to make up a machinery equipment of magnificent extent. One measure of this—perhaps as good a one as can be given—is the money value of the outfit. In one building, a hotel structure, now going up in the city of New York, the cost of the steam power, heating and ventilating plant will be in the neighborhood of $250,000, while that of the electric lighting installation will figure up to even more, $300,000.

Hydraulics

THE GOVERNMENT OF WATER POWER—II.

By Mark A. Replogle, Engineer.

(Concluded from Page 49.)

"Capacity of plant for stored energy," the third element to be considered in the government of water-power, is perhaps the most important factor, and often receives the least consideration. It is too often a chance factor. The capacity of the plant for stored energy may be easily understood. The following comparison partially illustrates the idea: To reduce the walls of a fortress may require a gang of laborers to use their united energy for several months of time, yet a few hundred pounds of steel in the form of a projectile fired from a cannon can in an instant be charged with energy enough to carry it a number of miles, and at the end of its flight it yet may retain power enough to reduce the fortress in a moment of time. This principle of storing energy in material in motion is the fundamental principle of all speed government.

If the above cannon ball were forged into a fly-wheel and could be revolved on its axis with such rapidity that its average speed equaled the velocity that it had when fired from the cannon, it would contain the same quantity of energy, and this quantity might amount to many thousands of foot-pounds. In speed regulation this stored energy can be used to supply the demands for power until gravity can generate it; in like manner this capacity for energy storage can absorb power when the load has decreased until the power supply can be shut off. It can readily be seen that any and all of the moving or revolving parts of a power plant are store-houses for energy, and their capacities depend upon their weights and velocities. The physical laws governing the quantities of energy under the various conditions are well understood by our scientists and engineers; hence, advantage can be taken of them in the construction of our modern water-power plants.

The careful steam-engine builder has learned by experience that he must provide this power-storage capacity in his engine, and he varies it according to what is required of it in government. There is no doubt but that the use of flywheels on engines is a result of experience in trying to maintain even speed, and that their prime purpose is to carry any change in load until the power supply from the boiler can be brought into play to carry the new load and to supply the power that the fly-wheel gave out in advance of it. The time required to get gravity effects is always greater than the time required to get the expansive effects of steam; therefore, the capacity for power-storage should be correspondingly greater in water-powers if the same efficiency of regulation is required.

The momentum of water-power plants is often very much less than that of steam-power plants, and this lessens the possibilities of government to an extent determined by the changes in load, the time required for gravity to act, and the quantity of power stored in the moving parts of the plant. This factor, power-storage, cannot be too carefully considered. It is the factor above all others that the designer of a water-power plant can most easily control. It is the one factor that can be varied to counteract all the bad effects of all the others; therefore, an intelligent application of it should be made in all water-power plants where good government is important.

The last factor to be considered is the "governor." The governor is often considered to be the most important factor in the government of a water-power; but it is only one of the important factors, and if it is a perfect machine it may still be limited in its efficiency by the three above discussed factors. A good governor can only play the part of an honest judge: Evidences of strife in the form of changes in load are placed before it; facts of design and construction are placed at its disposal; the unerring laws of physics are brought to bear on each new case, and honest judgment is meted out in the form of speed or government of the plant, and no jury or supreme court can set aside the verdict.

A good governor must move the wheel gates as fast as gravity will respond in giving the proper velocity to the increased quantity of water required to supply the demand made for power. If it operates too fast, the results are detrimental to good government. The governor must have wrought into it the principles that co-operate with the power storage of the plant. It must be so designed and constructed that it will stop moving the gates when they have reached the proper position to supply power for the new condition of load. A good governor must make its judgments quickly and accurately, always returning the speed to normal after correcting the inertia and momentum effects of the change in load. A good governor should also be simple in design and mechanism; otherwise, it will be an expensive and unsatisfactory part of the plant. The constant and reliable duty expected of a governor requires it to be a powerful machine; the positive and quick judgments it must make requires it to be sensitive and delicate in some of its parts, and the importance of its position in a plant requires it to be symmetrical in appearance and mechanically perfect in its construction.

The possible regulation in a water-power plant need no longer be a matter of experiment and doubt. The designer of such a plant need no longer be in darkness as to the government of his plant until he has experimented with several governors. He can design his plant for any desired efficiency of regulation, and a properly designed governor can govern it.

All plants already built are capable of a certain degree of regulation. If this degree is not satisfactory and figures show that it cannot be improved, then further calculations will show positively what changes must be made in order to obtain the desired results.

In conclusion, it should be said that if the limitations of water-power government were investigated more carefully, there would be less doubt concerning the results in any particular case. Many of our conservative engineers who have not taken time to make these investigations, have still some doubts regarding reliable and automatic government of water-powers; but the results where these limitations have been intelligently calculated and the proper remedies applied, prove beyond all doubt that any desired efficiency of government can be provided for, even to the finest steam-engine practice.

WATER POWER UNDER HIGH HEADS.

In the Engineering News for July 8th, appears a long editorial discussing difficulties in the use of water power under high heads and which, being opportune

with the publication of Mr. Replogle's article preceeding and with the unusual interest that the development of such plants has awakened on the Pacific Coast, is reproduced below in abstract:

In an article in another column,* Mr. John Richards, of San Francisco, gives a brief account of some of the difficulties which have been experienced on the Pacific Coast in the development of water power under great heads. To get a clear idea of just what these problems are, let us take a practical example. Suppose we have a pipe 12 ins. in diameter and 100 ft. long delivering water to a water motor. Suppose the pipe is vertical, so that the static head is also 100 ft. and that the water is flowing through it at the rate of 6 ft. per second to supply the nozzle or contracted orifice at the lower end through which it issues against the buckets of a wheel. The weight of water in that 100 ft. of pipe will be 4,900 lbs., and its velocity of 6 ft. per second is equivalent to nearly 4 miles an hour, about the rate of a rapid walker. The energy stored in this moving mass of water is

$W \frac{v^2}{2g}$ equal to 2,750 ft. lbs. At this velocity the pipe will deliver 277 cu. ft. per minute, weighing 14,790 lbs.; and as the head (neglecting loss by friction) is 100 ft., the total useful effect will be 1,479,000 ft. lbs. per minute. Dividing this quantity by 33,000, we have the horse power of the fall at 45 h. p. Suppose that the load on the motor is reduced to 15 h. p. That means (neglecting the friction of the motor itself) that only one-third of the amount of water should be applied to the wheel. Its velocity in the pipe will then be 2 ft. per second instead of 6 ft., and the energy of the mass of water in the pipe will be only one-ninth as great, since this varies with the square of the velocity. That is, it will be only 305 ft. lbs. instead of 2,750 ft. lbs., a decrease of 2,445 ft. lbs. Now, something must be done with this 2,445 ft. lbs. in order to reduce the velocity of the water to the extent we have supposed. It is certain to expend itself somewhere. Were we instantly to close the orifice, it would expend itself in tearing the pipe open. If we close the orifice only partially, the inertia of the water immediately raises the pressure at the lower end of the pipe and the water issues with greater velocity than before. This added velocity represents additional work, the source of which is the inertia of the water in the pipe, and as the inertia is gradually absorbed, the velocity falls back to its former amount.

The inventors of water wheel governors have been exerting themselves in every way possible to secure quick moving valves and valve motions in their attempt to secure close regulation of speed. We do not say that they are not working in the right direction, but let us suppose that some one should really devise a governor so perfect that at the same instant the load on the wheel was reduced to one-third, it would close the gates admitting the water to the wheel to one-third their former opening. Let us suppose that this movement is actually instantaneous, and see what would happen in that instant. In the first place it is clear that the water in the pipe could not change its old velocity of 6 ft. per second instantaneously, hence for an instant the same amount as before must be delivered through an orifice one-third as large, or at three times the velocity. The old velocity was that due to a static head of 100 ft., or 80 ft. per second. The new velocity will be 240 ft. per second, which corresponds to a head of 900 ft., or a pressure of 391 ft. per sq. inch. As the same amount of water is issuing as before, but under nine times the head, the work done to the wheel will be nine times as great. Of course, this high pressure on the pipe line and increased work on the wheel are merely for an instant. At the same instant the inertia of the water in the pipe begins to be absorbed the velocity begins to fall off, and with it, of course, the quantity of water delivered to the wheel. If the velocity and delivery which we found above were to remain constant, it would be only 1-82 of a second before the 2,445 ft. lbs. of inertia, which appear when the velocity of the water in the pipe is changed from 6 ft. to 2 ft. per second, would be absorbed.

The supposition we have made is not a practical possibility. No valve can be opened or shut instantaneously, and as a matter of fact, in all water wheel governors the large size of the valves makes their closing very slow as compared with the valves of a steam engine, for example. The above discussion shows, however, that even if this could be overcome, the difficulties in close regulation of water wheels would not be at an end. The first effect of the partial closure of a water wheel gate taking its flow from a long conduit is an actual increase in the work done on the wheel, and conversely, if with an increase of load the gate is slightly opened, the first instantaneous effect is to reduce instead of increase the work done on the wheel.

These are correctly spoken of as instantaneous effects. In the case of pipes of moderate length they may never become practically noticeable. With very long pipes, in which water flows at high velocity, they may cause a vast amount of trouble if they are not foreseen and provided for.

The practical rules which may be easily deduced from the foregoing discussion are two. Since in every water power plant it is desired to reduce the difficulties from irregular governing of the motors and excessive pressures on the pipes as much as possible, the engineer should endeavor (a) to make the length of the pressure pipe as small as possible; (b) to make the velocity in it as low as possible by making the diameter as large as possible.

In almost all cases the increased cost of a pipe of larger diameter will make it not feasible to increase the diameter merely for this reason, but it is well for the engineer to understand that this is a desirable end to be attained.

In the direction of reducing the length of the pipe much more can be done. The engineer, for example, can often take his choice between running a pipe from the source of supply directly to the place where the power is to be utilized and running either a pipe or an open channel on the hydraulic grade line to a point as near to the power house as possible, and from there running a pipe to the power house on a steep grade. When this choice is offered to an engineer, the plan that gives the shortest length of pressure pipe should be adopted.

It is often supposed that the pressure at the lower end of the conduit is the important item as respects the difficulty in governing water wheels, but this not really the case. The pressure has a practical influence as respects the weights of the gates to be moved, but so far as the inertia of the water is concerned, which has to be taken care of when a change in the load of the wheel occurs, it is the length of the pipe and not the head of the water at the exit that is the important factor.

Let us examine the different methods proposed or possible for solving this problem. The simplest way, doubtless, is to maintain a uniform flow of water in the conduit, and govern the wheels by deflecting the nozzles slightly when the demand for power falls off. The objection to this is that it is wasteful of water. The amount of water used is always equal to the maximum load.

A method which gives good results in the case of closed turbines is to govern the flow by throttling the escape from the wheel. It will be seen that the inertia which has to be disposed of when the flow in the supply conduit is checked is, in this case, not applied to the wheel at all, but is expended in giving velocity to the water escaping from the wheel. But this method is not applicable at all to open bucket or impulse wheels, and it has the disadvantage that, except when the wheel is working at full load, a considerable amount of power is wasted.

The attachment of air vessels to the supply conduit is a common mode of solving the problem, but the difficulty is that, unless an air vessel is of enormous size, it can absorb only a very small amount of power under the conditions existing in a water power plant. It must be remembered that an air vessel operates only

* The substance of Mr. Richards' article is embraced in the issue of the JOURNAL OF ELECTRICITY for October, 1896, describing the Cobb relief valve.—EDITOR JOURNAL OF ELECTRICITY.

by the increase in pressure in the conduit to which it is attached, and the work it stores is only that required to compress the volume of air which it contains from its initial to its final pressure. But to fulfil the requirements of good governing of the water wheels, the pressure cannot be allowed to increase very much above the normal.

The proper use of an air vessel (and its value for this purpose is unquestionably great) is to take care of the inertia of the flowing water when a gate in a long conduit is entirely closed. As every experienced hydraulic engineer knows, the very greatest care is necessary in closing a gate in a long conduit to prevent a "water ram" that will burst the pipes. In a conduit under pressure, the metal of the pipe has very small power to resist shock. But when the gate is closed slowly, the velocity is reduced until the amount of energy in the flowing conduit, which the air chamber has to absorb when the escape of the water is finally cut off, is very small.

Mr. Richards, in his paper above referred to, states that when the flow in a long conduit is suddenly checked, pulsations of pressure are set up. The foregoing study of the actions of water under such conditions makes one cause of these pulsations plain. Suppose we have a water wheel with a governor which operates by throttling the flow of water to the wheel, the almost invariable practice. Suppose the load on this wheel is reduced one-fourth. The speed increases and the governor begins to close the nozzle; this raises the pressure in the pipe and, as we have already seen, actually increases for a moment the work done by the jet on the wheel. The effect of this on the already underloaded wheel is to increase its speed still more, causing a further movement of the governor, and another increase in pressure. The net result of the action is to cause the governor to close the nozzle until the flow is reduced below what is necessary for the load on the wheel. Then the speed of the wheel is reduced below the normal and the governor begins to open the throttle valve, which causes a drop of pressure in the conduit, and the same cycle is repeated until an equilibrium is finally reached. These occurrences, of course, take place with great rapidity, and constitute that rythmic pulsation which is described by Mr. Richards and also by the writer* who describes the Fresno power plant in another column.

The reader who has followed the above discussion can now form an intelligent opinion as to the merit of the device of Mr. E. S. Cobb, described in Mr. Richards' paper. It appears to us to be an excellent device, and likely to prove effective if properly designed. We desire to call especial attention to the waste valve of this device, which appears to us likely to prove the best method for controlling the flow in long pipes and solving the difficulties in governing the speed of wheels, and in controlling the pulsations and shocks in the pipe to which we have referred. Such relief valves should be proportioned to the size of the pipe they control, and should be located as near to the nozzle of the pipe as practicable. They should be so loaded as to open automatically when the pressure in the conduit rises somewhat above the normal working pressure, and would then act to prevent the further increase of pressure in the pipe. The water wasted through them would be comparatively small in amount and would furnish, we believe, the cheapest and simplest way of taking care of the energy that appears when the velocity of flow in the conduit is checked.

In any case it is true that to secure good governing these valves would have to open at a pressure lower than that due to the static head on the pipe. But it would be a simpler matter in any such case to make part of their load removable, so that when it is desired to entirely shut off the flow there may not be a waste of water through these valves.

In conclusion, the reader cannot fail to have perceived that to secure good governing in hydraulic motors working under high pressures, sufficient time is an absolute essential. We cannot suddenly change the rate of flow in a long conduit, but we can do so gradually without difficulty, and the best thing that can be done when a water wheel must be driven from such a conduit to carry a rapidly varying load is to furnish a reservoir of energy in the shape of a heavy fly wheel on the water wheel shaft. By this means the changes in the speed of the water wheel may be made so gradual that a similar variation of flow can be made in the conduit without causing either excessive variations of pressure or waste of water.

While all our foregoing discussion has referred solely to the problems encountered when water power is developed from long conduits, the use of fly wheels in any water power plant will be found to be of great advantage. While the engineer has no difficulties with pulsation of water hammer to encounter when a turbine takes a supply directly from a fore-bay, the difficulty in quickly moving the gates of the wheel when sudden changes of load occur makes the steadying effect of a fly wheel of great value here as well.

Cast iron is very cheap and the maintenance of a good many tons of it in the shape of fly wheels is a very small item. We believe the engineer entrusted with the design of hydraulic power plants who is liberal in his provision of fly wheels will find them the best insurance against difficulties of the class which we have described.

* Geo. P. Low in the "Fresno Edition" of the JOURNAL OF ELECTRICITY for April, 1896. Reproduced without proper credit in "The Engineer," London.—EDITOR JOURNAL OF ELECTRICITY.

Fraternal

THE A. I. E. E. GENERAL MEETING.

The fourteenth General Meeting of the American Institute of Electrical Engineers will be held at Greenacre-on-the-Piscataqua, Eliot, Me., on July 26th, 27th and 28th.

The opening session will be held on Monday, July 26th and the following papers will be presented:

"The Precision of Electrical Engineering." Inaugural Address, by the President, Dr. Francis B. Crocker, of New York City.

"The Alternating Current Induction Motor," by Charles Proteus Steinmetz, of Schenechtady, N. Y.

"A New Form of Induction Coil," by Prof. Elihu Thomson, of Lynn, Mass.

"Effect of Heat Upon Insulating Materials," by Putnam A. Bates and Walter C. Barnes, of New York City.

"The Effect of Armature Inductance upon the Electromotive Force Curves of an Alternator," by Prof. W. E. Goldsborough; of Lafayette, Ind.

"Electric Metering from the Station Standpoint," by Caryl D. Haskins, of Boston, Mass.

"Development of the Fire Alarm Telegraph," by Adam Bosch, of Newark, N. J.

"Electrical Traction.—Notes on the Application of Electrical Motive Power to Railway Service, with illustrations from the Practice of the Metropolitan Elevated Road of Chicago," by M. H. Gerry, Jr., of Chicago.

"The Cost of Steam Power," by Horatio A. Foster, of Buffalo, N. Y.

"Efficiency and Life of Carbons in Enclosed Arc Lamps," by W. H. Freedman, of New York City.

"Armature Reactions in a Rotary Transformer," by Prof. Robert B. Owens, of Lincoln, Neb.

"Recent Applications of Storage Batteries to Electric Railways," by Herbert Lloyd, of Philadelphia.

"The Economy and Utility of Electrical Cooking Apparatus," by Prof. J. P. Jackson, of State College, Pa.

Historical

A LESSON IN DYNAMO DESIGNING.

He was a rather crochetty old fellow, and as he bent over his work, the shop-foreman observed that he was at once the most crabbid and the most interesting man about the works. "Sometimes," said the foreman, he'll snap your head off if you ask him the most civil question; at other times he'll talk away most agreeably. As for a workman, there's no better in the country and, by the way, he was with Ball when the Ball dynamo was invented."

Here, then, was an opportunity, perhaps, for enlightenment concerning that much-talked-of, that declared to-be-impossible, that universally-derided, yet altogether successful, that so-called "unipolar," Ball dynamo, and the possibility of learning, even indirectly, the views of the inventor, made the irascability of the old man to be no barrier. Indeed, at the mention of "Ball dynamo," the old man's irritable mein vanished into one of affable retrospection. Plain, unpretensions and straightforward as to the English used, the old mechanic told how the Ball dynamo became a reality and, were the truth known, perhaps the humor of this narrative may relate between its lines, the fact of many an invention that has brought both weal and fame to its originator.

"You want to know how Ball came to invent that dynamo, eh? Well, sir, I'll tell ye," he replied. "It was just this way, and after I'm done tellin' ye, kind o' make up your mind if 'twas invention or what. You see, Ball wan't no electrician then. He wor a machinist like me now, and when he brought out his dynamo that everybody laughed at an' said would'nt work, he was running a machine shop. In them days, everybody was building dynamos and he thought he'd build one too. So he just put up an arc machine with four field coils,, 'consequent pole' type they call it, and had the armature shaft run through the yokes parallel with the fields. She worked all right with a few arc lights, but he thought it didn't run enough lamps, so he just run her faster and she run more lamps, then he run her faster yet, and the blamed armature busted.

"You see he wa'nt no electrician, he was a mechanic, and when a mechanic has a machine break down on him, he's going to find out the reason why. So he just took that armature and sawed it right through crossways of the shaft, you know, when he see that the inside wires next the core were the ones that got hottest and then he says to himself, says he, 'if them blamed wires weren't wrapped on so thick, or if the machine was fixed so as to let the air get at 'em more, she'd be better off. So he makes two armatures and puts 'em on one shaft and lets each armature have two pole pieces so they'll get more air and then let her go, and, I tell ye, she started off fine. Then pretty soon he kept on adding lamps and driving her faster, thinking he'd ought to get more lamps out of her, when up goes both armatures in fire and smoke.

"That was hard luck, but Ball still thought the idea was all right and we were set to work and made the armatures over new, but before we got the machine put together again something interfered and Ball got kinder out of the way of tinkering with the electric business and the parts of the machine were left laying around the shop. Finally one day, maybe six months or a year afterwards, after they had had a directors' meeting and all the directors were standing around the shop talking, one of 'em said 'Say, Ball, what's the matter with your arc light dynamo that you was going to do so much with?'

" 'The dem thing ain't no good, that what's the matter with it,' says Ball.

" 'Why ain't it no good?' says he.

" 'Just wait a little while and I'll show you,' says he.

"Then they all went down to the shop and Ball told us men to put that dynamo together quick, and we hurried like the old Nick was after us, and in a little while we had her rolling bully.

" 'You see,' says Ball to them directors, 'she'd ought to carry more lamps, but she won't; now watch her.'

"With that, Ball put on more lamps and more steam and she carried 'em. Then he put on some more, and then some more, and I'm blamed if she didn't carry 'em all fine.

" 'Gee whillikins,' thought I, 'what's the matter with her anyhow? She never carried so many lamps as that before.' Ball, too, seemed puzzled; then he gave her a look as much as to say 'I'll bust her anyhow' and ordered us to slap on another batch of arc lamps and threw the valve wide open. The old machine just tore around like wild, but she carried the lamp all right though. But, by and by, bang went an armature and the jig was up.

" 'There,' says Ball to the directors, 'that's why the dem thing ain't no good.'

"After they was gone, I kept scratching my head and thinking how fine she carried that big load and what a fool Ball was to burn her up because he had told the directors she was no good and didn't like to take water. I felt kinder bad about it and wandered back to the machine to see how she had busted this time.

"Well, sir, begosh, would you believe me, Ball had hurried us men so in setting up the machine that we plumb forgot and left off one of the pole pieces so that one armature had only one pole piece and the other one had two. And, sir, the armature that was burned out was the one that had the two pole pieces, and when Ball saw it he just said to himself, 'by golly, I'll give each armature only one pole, blamed if I don't'—and he did.

"That was how Ball's dynamo was invented. He didn't know nothing about electricity, nothing at all; he was a mechanic like me, but his machine is a good one even if it is built in a way that electricians said wouldn't never work."

THE NIAGARA FALLS CONVENTION.

The twentieth annual convention of the National Electric Light Association, held at Niagara Falls, on the 8th, 9th, and 10th of June, was considered by the delegates to be one of the most successful gatherings in the history of that organization. A number of very interesting papers were read and discussed. The attendance was unusually large and the exhibitions of electrical apparatus made by the different supply houses throughout the country was of more than ordinary completeness. The exhibition of the Westinghouse Electric and Manufacturing Company was especially attractive, owing to its completeness and the many interesting features which it contained. The Company had on display several Induction Motors, Direct Current Generators, Alternating Current Generators, Switchboard Apparatus, Lightning Arresters, Converters, Arc Lamps and Incandescent Lamps. The latter forming an exhibit made by the Sawyer Electric Company, of Allegheny City, Pennsylvania.

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EDITORIAL.

CALIFORNIA LEADS THE WORLD.

The rapid advance which is being made in California in the use of higher and yet higher potentials in the electrical transmission of power bids fair to far surpass the most sanguine estimates of conservative thinkers. As recenty as September last, Dr. Louis Duncan, in his presidential address to the American Institute of Electrical Engineers, discussed the possibilities of long distance electrical transmission and presented a tabulated list of the principal transmission plants in the world, observing that "the longest transmission is at Fresno, Cal., the distance being about 35 miles. The highest alternating voltage used is 13,000 volts at Zurich, Switzerland. The highest direct potential is 15,000 volts at Brescia. All of these plants are working successfully, and this fact will lead to still longer transmission and higher voltages. No limit of either distance or potential has yet been reached. If we consider the record of the present transmission plants, we can safely say that it would not be going outside of the safe limit of development to transmit at least 50 miles at a potential of 20,000 volts, provided the energy could be delivered at such a price as to be considerably lower than the cost of a corresponding amount of energy obtained from a steam plant."

But ten months have passed since the rendering of this eminent opinion, but this brief period has seen the complete success of the Westinghouse 15,000 volt alternating current transmission of the Central California Electric Company into Sacramento, Cal. The laurels for the longest distance transmission have passed from Fresno to Ogden, Utah (36 miles) and now contracts have been awarded to the General Electric Company by the Southern California Power Company for the transmission of about 4000 horse power from the Santa Ana River to Los Angeles, a distance of 81 miles, the potential to be employed being 33,000 volts, alternating current. Not a well-grounded doubt has been expressed that the undertaking will not be crowned with success.

It is indeed a happy combination of circumstances —this abundant water power, this high-priced fuel, this immunity from snow, sleet and humidity—that makes the great valleys of California the proving grounds of the electrical transmission of power. More than this, capital invested in electrical transmission enterprises in California is not ventured as in less favored localities where the elements, as if filled with malicious envy, do their uttermost to balk and thwart the efforts of engineering skill.

The eyes of the electrical engineering world have been, and are, and will be. centered on the thrice-favored valleys of California, the nursery where transmission enterprises are reared and develop from experimentation to success.

LUCK IN DAILY LIFE.

One of fortune's most favored sons has defined luck as being the ability to perceive opportunities and to take advantage of them, rather than as being "a favorable issue or combination of events" tending to good fortune. The lucky man in the eyes of the world, is a creature of chance, sometimes without ability or worthiness, but who has stumbled into fame or a bountiful share of life's good things. They say that his striking a bonanza was purely accidental, overlooking the years of application that led him to successfully prospect it; or that by mere accident he was mounted to a lucrative sinecure, quite unmindful of the assiduity that was his stepping stone, or that he happened to hit upon an idea that had millions in it, as though ideas, like rare gems, were but to be picked up to bring the finder's own figure. Indeed ideas are one thing; their adaptation is quite another matter requiring the exercise of a special talent, either natural or artificial It may be pleasing to paint fortune as a fickle goddess, but it will be maintained that she bestows her favors as the reward of diligence, of perception or of experience. Luck ofttimes prevails, but its realm is not so broad as the popular idea leads to believe.

Man is by nature a fortune-hunter—a searcher for success, and how may his ambition for success best be satisfied? Surely not by deep-rooting the belief that luck is omnipotent—that it alone shapes man's destinies. It is wisdom to teach that luck is an artificial and not a supernatural creation, that it constitutes a reward for properly applied energy and that it is synonomous with the ability to perceive and take advantage of opportunities that daily arise.

The engineering field is most prolific of these opportunities. They are not obtrusive. They do not confront one as a reality but, subtile and evasive, they may easiest be found within the vast domain entered through the portals of knowledge. They pertain to all

subjects and they are as diversified as is human industry. The world is full of opportunities and the finding and availing of them is the watchword of every successful man.

In brief, it is not by any means true that luck always makes the man; generally the man who turns opportunities to his own advantage is the one whom the world considers lucky.

THE USE AND ABUSE OF TRANSFORMERS.

On another page of this issue begins the first article of a serial on "The Use and Abuse of Transformers", in which is brought out in a clear and convincing manner the various technical points, good or bad, which influence the standard of excellence of the transformer of today. The efficiencies attained in the leading transformers show them to be devices that have almost reached a point of perfection, but on the other hand, there yet exists and are largely used, transformers of such inferiority that their displacement by the latest types in the manner to be indicated in the serial, would in many cases effect an economy that would defray the cost of the change within a surprisingly short period.

If the article be criticized unfavorably it can only be on the ground that it deals particularly with transformers made by the General Electric Company, but nevertheless, such endorsement as is there given is well merited. More than this, however, the article speaks truths in almost every line that the prudent and painstaking station manager cannot digest too thoroughly. The article must stand endorsed, therefore, as the most clear, lucid and convincing yet written with a view of spreading education concerning the use and abuse of a most familiar device whose principles of operation is less understood by the generai electrical public, than any other appliance known to the industry.

TESTING HIGH POTENTIAL INSULATORS.

The transmission companies of the Pacific Coast will find more to interest them in the paper read by Mr. J. G. White on "The Niagara-Buffalo Transmission Line" before the Niagara Falls meeting of the National Electric Light Association last month, than in any other contribution to that unusually instructive convention. Of especial interest is the section of the paper devoted to insulators and the croakers who have predicted the impossibility to insulate for 33,000 volts, as is proposed to be used on the line of the Southern California Power Company, will find little consolation in learning from Mr. White's paper that all the insuators in use on the Niagara-Buffalo line have been submitted to a test by the Cataract Construction Company, of 40,000 volts.

The method of making this test is described as follows: The insulators were set inverted in a shallow iron pan, in lots of about 20, the bottom of the pan being covered with an inch or two of water containing a little salt. A little of the same brine was poured into the pin-hole of each insulator, and into this was thrust a small piece of metal such as an ordinary iron spike or a small round zinc rod from a sal-ammoniac battery, this being connected to one side of the testing circuit, the other being connected to the pan containing the insulators. After the metal rod had been placed in the brine in the pin-hole of an insulator, the primary circuit of the testing transformers, specially built for the purpose, was closed and if the insulator was weak, this was quickly manifested by a series of sparks through the punctured porcelain. Experiments made with pure water and with brine showed that there was no difference in the results, but that any weakness was manifested a little more quickly with brine, besides which the salt imparted the characteristic bright sodium color to sparks, otherwise almost coloress and difficult to detect.

Mr. White's paper points out many interesting facts which were developed during these tests and are worthy of note. The insulating strength of porcelain depends almost entirely on the thoroughness of its vitrification and very little on its thickness, a thin China tea cup having successfully withstood a pressure of 60,000 volts, while a porous piece of porcelain two inches thick, was readily pierced by 20,000 volts. It is, therefore, practically unnecessary to test any insulator electrically which, when broken, will not pass a good absorption test, using red ink or other coloring fluid.

It is quite if not entirely impossible to puncture a glass insulator, even an ordinary pony telegraph insulator withstanding any pressure which can be applied, the last being determined by the pressure which will send an arc around the insulator. The objection to using glass insulators has been due to the difficulty in getting a well annealed and mechanically strong insulator of such massive design as is needed for this work and to the hydroscopic property of glass, which is not shared by porcelain. The first can unquestionably be overcome by care in manufacture. The importance of the second has probably been exaggerated in most calculations made in the past, due to an inadequate appreciation of the static effects of 10,000 volts in warding off snow flakes and drops of rain, and to a less extent of the rapidity with which water falling on such insulators is evaporated by the heat of the current leaking over the surface.

It is consequently, reasonable to expect that the use of glass insulators for high voltage lines will greatly increase with improved manufacture. Meantime, any lines erected should have the best obtainable porcelain, and every insulator should be subjected to test.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

TO APPEASE THE DEVIL.

The editorial appearing in the last number of the Journal discussing the difficulties that beset engineering undertakings in China has received significant confirmation in the report brought from the Flowery Kingdom by the British steamer Glenshiel, which recently arrived in San Francisco from the Orient. It seems that in the interior of China the coolies believe that the devil is responsible for the killing of people in railroad accidents and the new railway now being built into the interior from Pekin has filled some of the common people of the ancient empire with alarm, and it has been proposed that sacrifices of children be made to satisfy the devil and prevent him from killing people under the wheels of locomotives.

Many stories had been circulated before the departure of the Glenshiel from the Orient, and the number of children supposed to be necessary for the sacrifice varied from 2,000 to 10,000. Government interference, however, will probably prevent any such wholesale slaughter, but there is danger that some sacrifices will be made.

THE LONGEST ELECTRIC TRANSMISSIONS.

A contract for the transmission of power of the river running through the Santa Ana Canyon to Los Angeles and Pasadena, a distance of eighty-one miles, has been concluded between the Southern California Power Company and the General Electric Company. The amount of power to be transmitted at first is four thousand horse-power. The station will be located in the Santa Ana Canyon, twelve miles from Redlands and about eighty miles from the towns in which the electric power will be utilized. The water will be taken from the river through canal, flume and tunnel along the side of the canyon, whence it will be led into a pipe 2200 feet long, giving what will be equivalent to a vertical fall in the water of 750 feet. The wheels will be of the impact type, directly connected to the generators of which there will be four each of 750 kilowatt (1000 horse-power) capacity. The maximum line potential will be 33,000 volts, to which potential the initial voltage will be raised by twelve 250 kilowatt step-up transformers.

This transmission will be the longest commercial electrical power transmission as yet undertaken, as well as that using the highest voltage. At present the longest is that transmitting the power of the waters of the Ogden Canyon in Utah to Salt Lake City, a distance of 36 miles. The Los Angeles transmission will be over twice that distance, and three times the longest distance yet tried with the power of Niagara, which to date has only been transmitted to Buffalo, a distance of 26 miles.

Literature.

Any Book Published Mailed upon Receipt of Price by The Journal of Electricity.

THE MECHANICAL ARTS SIMPLIFIED. By D. B. Dixon. Cloth, $5\frac{1}{2}$x$8\frac{1}{4}$ inches, 497 pages. Appropriately illustrated. Laird & Lee, 263 Wabash Ave., Chicago, 1897. Price, $2.50, or as a premium with one year's prepaid subscription to the Journal of Electricity, $1.95.

It is no small task to comprehensively review a work of nearly 500 pages filled to the covers with data and tables of every description, in addition to innumenable rules for the solving of problems in arithmetic, mensuration, gears, centrifugal force—in fact, almost everything. No space is lost in preface or introduction; the index contains 16 pages and as the rest of the book is devoted to solid information of a mechanical and engineering nature, it is at least meaty. In brief, it seems as though the author had ransacked every trade catalogue containing statistics, and every handbook containing data, and every text book containing tables of weights, measures and values, and every school book indicating the solution of problems and had reproduced them all in this one most handy volume.

The Electrical Department of the book consists of 53 pages, 42 of which are devoted to a well-written and intelligible treatise of definitions of electrical words, terms and phrases. After describing at some length the fundamental units of electrical nomenclature such as the volt, ohm, ampere and the watt, and Ohm's law, candle power, and horse power, the various methods of wiring, such as the multiple arc, the series-multiple, the multiple-series, the series, and the Edison three wire systems are taken up and discussed with diagrams in such a simple way as would seem impossible for any one to misunderstand, however unfamiliar he may be with electrical usages. The treatise then passes on to a discussion of the properties of the circuit, touching clearly upon the circular mil, conductors and insulators, the resistance of copper wire, the determination of wires and the method of preparing a wire table, concluding this portion of the subject with several wiring tables for different classes of lighting service. Next is taken up the subject of motors. The wiring for motor circuits and services is discussed and the table is presented showing the amperes per motor at indicated efficiencies for various horse powers up to 150 and various voltages up to 1200. Another table is presented showing the size wire that may be required for any loss that may be adopted. A short section by Charles Wirt on "Simplified Copper Wire Equations" is then given, followed by a number of tables giving the properties of wires. The remaining portion of the electrical section treats of the principles and types of dynamo electric machines with competent points on their care and maintenance, together with descriptions of the various instruments and devices common to central station practices. The Electrical Department concludes in the reproduction of the wiring rules of the National Electric Light Association.

The preceeding paragraph relates only to the electrical department of the book and although electricity is treated more exhaustively than any other subject, it indicates fairly well the thoroughness with which subject matters are handled. Tables of weights and

measures require 11 pages; steam boilers, 14 pages; iron data, 30 pages; mensnration, 6 pages; pipe data, 29 pages; pumps, 6 pages; rope, 4 pages; timber, 3 pages; tubes, 7 pages; valves, 4 pages; wires, 8 pages; and wages, 6 pages. These subjects are taken at random from the table of contents and may serve to give an idea of the scope and thoroughness of the work.

For some time there has been considerable discussion concerning means for indexing technical literature, and it is a question that bids fair to remain a vexed one for some time to come. The necessity for indexing technical data is not, however, likely to be so productive of difficulty in its solution for Mechanical Arts Simplified has set a heroic example in gathering data and bodily republishing it in a form that is at once most handy and reliable.

Those who, in striving for mechanical and engineering data, have been forced to rely on a promiscuous assortment of bothersome trade catalogues for their information, may cast many of them to the winds after having secured Mechanical Arts Simplified for it truly goes a long ways toward solving all mechanical difficulties.

THE THEORY OF ELECTRICITY AND MAGNETISM, being lectures on Mathematical Physics, by Arthur Gordon Webster, A. B., Ph. D., Assistant Professor of Physics, Director of the Physical Laboratory, Clark University, Worcester, Mass. Cloth spring-back, $5\frac{1}{2}$x$8\frac{3}{4}$. Illustrated by 100 geometrical or diagrammatic figures. The Macmillan Company, 66 Fifth Avenue, New York, 1897. Price, $3.50.

It is pointed out in the preface that while some justification is perhaps necessary for the appearance of another treatise on the subject of Electricity and Magnetism, in view of the numerous ones already existing in English, the present work is the result of a demand encountered in the author's experience in teaching, and is based upon various courses of lectures he has delivered in Clark University during the last six years.

The classical treatise of Maxwell, the author observes, is ill adapted to the purpose of a text-book and to ask a student to attempt to assimilate the contents of two volumes of Maxwell in a year, or even in two years, is to expose him to the severest pangs of mental indigestion, and make severe demands upon his mathematical attainments. The excellent treatises of Mascart and Joubert and of Watson and Burbury follow Maxwell with considerable closeness. Professor Gray's admirable treatise, though containing much recent matter, suffers under the disadvantage of being in three volumes, while the very convenient little book of Mr. Emtage is somewhat restricted in scope. Finally, Professor, J. J. Thomson's altogether delightful Elements of the Mathematical Theory, which appeared very shortly before the present book, is extremely modern as well as clear but is addressed to a somewhat different class of students from that contemplated in the book now under review.

Again, the theoretical writings of Hertz, Heaviside, Cohn and others have resulted in the systematization of Maxwell's theory and have made possible improvements in the mode of its presentation and nomenclature not contemplated by him. The extremely important and original contributions of Heaviside are unfortunately but little adapted to the use of the student on account of the very voluminous character as a whole as well as of an extreme conciseness of expression in individual parts. The few brilliant chapters on theoretical matters left by Hertz are hardly by way of exposition, but rather of a summing up of the conclusions of the theory.

It has evidently been the author's aim, in the preparation of this volume to present to the student the results of the theory as it stands to-day after the labors of Faraday, Maxwell, Helmholtz, Herz and Heaviside, in such form as to be suitable for assimilation by the student in a peroid of time not exceeding a year. To this end he has considered only the usual mathematical methods of treating the various subjects and included enough examples to illustrate their working and no more.

Without doubt the book will succeed in clearing up many of the difficulties generally encountered by the student, and will induce him to read the classical writings of Maxwell, Helmholtz, Hertz and Heaviside, the digestion of which will ever be desirable.

Transmission

CHEAP POWER OFFSETS CHEAP LABOR.

Until a very recent time the idea prevailed that California could never become a great manufacturing State for lack of cheap fuel. Accordingly we began to import articles of every-day use from the East, confining our manufacturing enterprise, in a large degree, to wool, flour and lumber, and thinking to go no further. But the successful use in railroading of electrical power generated by impounded streams has made it clear that California, if it will, can have the cheapest form of motive power to be found in the United States outside the districts that enjoy natural gas. To dam up a canyon in the mountains, to hold the winter precipitation for summer use and to apply the force of gravity to the wheels and spindles of manufacture is a very simple way of solving the problem originally made by dear coal. We can work up our own raw materials cheaply with such a system, supply our own wants and those of the great Southwest and have a means of competing with Europe for the custom of the west coast of Spanish America. With cheap power we can counterbalance cheap labor, and with the shorter haul to our credit, undersell European exporters in those markets. So there is commerce as well as home industry to be conserved by our electrical development.

Owing to the topography of California all parts of the State that have aught to manufacture can share in the benefits of the new era. The two mountain ranges which traverse the State from end to end have an exhaustless supply of water, and the distance from them to any of the towns is not so great as to make the transmission of power impracticable. Northern, Central and Southern California are alike favored with streams that can easily be harnessed and made to do the same duty the year round which many of the great manufacturing States and countries are obliged to depend for upon a costly product of the mines.—San Francisco Chronicle.

THE WATER POWERS OF THE SAN JOAQUIN VALLEY.

Beginning at the Northern end of the San Joaquin valley, the first water power of any extent is that de-

veloped by the Blue Lakes Water Company, deriving their water from the Mokelumne River. This Company has for years had an extensive line of ditches used for mining purposes, has recently developed an extensive water power for use in transmission and for mining purposes on the Mother Lode and has in contemplation a still more extensive water power located about 28 miles from Stockton, where in the near future they contemplate delivering power.

Farther south, an extensive water power can be developed on the Stanislaus River, a distance of about 40 miles from Stockton, and some progress has already been made towards the utilization of this power and its use for various manufacturing and other purposes in Stockton.

Next towards the south is the Merced River. Water power to a considerable extent has been planned for development at three points on this river, located at Snelling, Horseshoe Bend, and Jenkins. The first of these is especially intended for supplying power to an electric railway from Merced to the Yosemite Valley.

Still farther south at the head water of the San Joaquin River a water power to the extent of several thousand horse power has been developed by the San Joaquin Electric Company. Electric machinery generating about 1500 horse power, together with transmission line 35 miles distant to Fresno, and arc, incandescent and power machinery in Fresno have been installed for the San Joaquin Electric Company by the General Electric Company. This plant has been in successful operation now for a period of a little over a year and has practically demonstrated both the value of this water power and the success of long distance transmission, this being the longest commercial electric transmission plant in the world.

Next to the south is a water power, planned for development on the Keweah River, a distance of 19 miles from Visalia. About 600 horse power can be developed and plans are already perfected for the utilization of this power for the transmission of electricity to Visalia, Hanford and other near by towns.

Farther south and last on the list is the Kern River, on which an extensive water power has already been developed by the Power Development Company. The General Electric Company has installed a plant for this company with transmission line a distance of 16 miles to Bakersfield, and including motors for pumping and transformers for lighting in Bakersfield. Contracts have also recently been made for an extension of this system to a distance of about 20 miles beyond Bakersfield, making the entire transmission nearly 36 miles. Much of this last mentioned power is used for purposes of irrigation.—Dr. Thomas Addison in the Commercial Bulletin, San Francisco.

A GREAT TURBINE PLANT.

The power company at Niagara Falls has now in successful operation its new power plant, consisting of four of the Leffel Celebrated Niagara Type of Turbines, each of about 2,200 horse power capacity, or giving in all some 9,000 horse power. These Turbines drive eight generators of something over 1,000 horse power each; two generators being connected directly to the shaft of each wheel, one being placed on each side.

This comprises the most complete and perfect electric water power plant in the world.The same company have four other of the Leffel Niagara Turbines, using in all eight of that style of wheel.

Illumination

AN ELECTRICAL RIVAL OF THE ARC LIGHT.

In a contribution to Wiedemann's Annalen, No. 12, Herr O. Schutt, of Jena, describes a new electric discharge phenomenon, which he terms electro capillary light. When the discharge of an induction coil is sent through a narrow capillary tube of about 0.05 mm. in diameter, provided with aluminum or copper elctrodes and filled with air under ordinary pressures, an intense luminosity of the tread of air is obtained—a luminosity which is intrinsically far superior to that of the arc, and would form an exceedingly powerful source of light if it could be made continuous. The narrow capillaries deteriorated rapidly, roughening inside, and were blown into a series of spherical enlargements. Wider tubes gave less light, but were much more permanent. At the same time the bright lines in the continuous spectrum in the original light became more prominent. At pressures above one atmosphere the phenomena were nearly the same, but the sparks passed with greater difficulty. At low pressure the light became less intense, the continuous spectrum faded, and the bright lines shone out more distinctly. The kind of glass is immaterial. It is stated that the tubes may be made 20 centimeters long and make splendid line sources.

ENERGY FROM VOLCANIC HEAT.

The energy stored in the coal beds has rightly been referred back to the sun, and it is, no doubt, to the same source that we should ultimately attribute the heat developed at great depths below the surfce of the earth. While it is believed that no practical attempts to utilize this subterranean heat have yet been carried into effect, there appears to be no good reason why the attempt should not be made, especially in volcanic regions, where quite high temperatures should be revealed at moderate depths. In a Colorado mining town an interesting combination was recently observed which a little ingenuity might have converted into a considerable source of power. Within twenty feet of each other were two springs, one of a temperature of nearly 200 degrees F., and the other not over 60, the flow of each being very uniform and the temperature quite constant. The theoretical efficiency might readily be determined from the well-known law of thermodynamics, and the use of one stream to vaporize and the other to condense some volatile liquid, such as ammonia or bisulphide of carbon, might enable a fair percentage of the energy to be utilized which is now running to waste.—Cassier's Magazine.

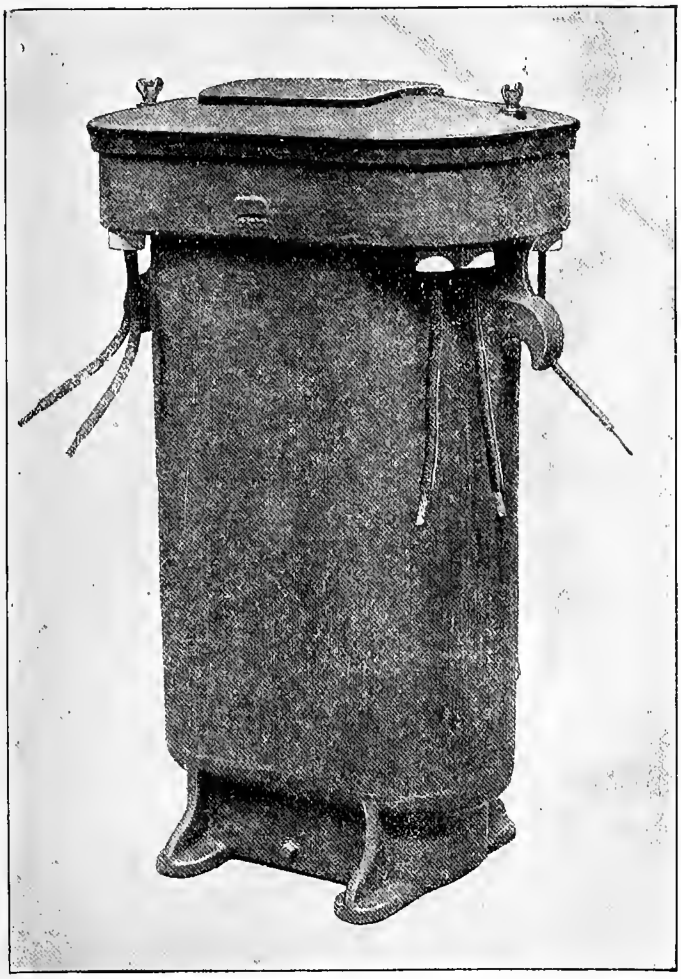
NO EYRIE THERE.

The unexpected short-circuiting of one of the 10,000-volt transmission lines of the San Joaquin Electric Company, which recently caused a shut-down of one line for about twenty-five minutes, resulted from a curious cause. Two eagles, male and female, had perched on a live wire near the power house, thirty-five miles from Fresno. The birds were electrocuted, but it was not till after a diligent search that their bodies were picked up and the short circuiting of the wire explained.

Electro-Economics

THE USE AND ABUSE OF TRANSFORMERS.

The distribution of electrical energy by transformers, coming into use as it did at a time when electrical plants were being installed rapidly and the whole electrical business was being expoited in a most vigorous if unsystematic manner, was not, in the early stages of its development, closely criticized by the users; it was sufficient that this method accomplished results which could not be obtained in any other way.



TYPE H TRANSFORMER—20,000 WATTS.

At the present time, when the electrical business has settled down into more conservative lines, it is of the utmost importance to look over the field and to view, without roseate spectacles, the qualities of the apparatus upon which the success of many electrical enterprises depends, and especially to see what has been done in improving such apparatus and rendering it more desirable and economical to the purchaser. The discussion may be conveniently divided into three parts:

Part i.—The Essential Properties of Alternating Current Transformers.

Part ii.—Proper and Improper Methods of Distribution.

Part iii.—Results Obtained by Exchanging Bad Methods for Good.

Part i

THE ESSENTIAL PROPERTIES OF ALTERNATING CURRENT TRANSFORMERS.

The three qualities which are essential to the successful commercial use of alternating current transformers, are—Durability—Efficiency—Regulation.

It is sufficiently obvious that any transformer which cannot be depended upon, and which is liable to be subject to serious depreciation, is not fit for commercial use. It is of the utmost importance that transformers, which have to be put in all sorts of places and exposed to all sorts of weather conditions, should be thoroughly well made and should be so constructed as to be relatively safe against breaking down of the insulation in either coil, the breaking down of insulation between the coils, and surface leakage. Destruction of the insulation of either coil means very serious damage to the transformer. Destruction of insulation between the coils or at the surface of the transformer means serious danger to life and property. Nearly all the accidents involving these most grave matters have occurred through one or the other of the causes mentioned. In respect to the foregoing, that transformer is best which is most thoroughly insulated, and thorough insulation means not only care in selecting materials and applying them, but such general design that no considerable difficulties are encountered in insulating the transformer, from the shape, position and contiguity of its various parts. In this respect transformers of all makes have improved since the early days of the transformer business, and it is but natural to expect the latest type of transformer to be the best. An inspection of the Type H transformer of the General Electric Company, which embodies the latest and best methods of design and construction, will show how completely these most important conditions have been fulfilled.

DURABILITY.—The illustration of the standard Type H transformer displays very forcibly the valuable character of the improvements which have been introduced in it. In the first place it should be noted that the coils are of such shape that they can be easily wound without danger of bruising and damaging the insulation. There are no sharp corners to be turned and no contracted spaces into which wire has to be forced. There is but one surface of separation between the primary and secondary coils and this surface is a smooth curve, to which insulating material can be uniformly and thoroughly applied without danger of defects in the workmanship, or injury in assembling. It is easy with this construction to allow ample insulation space between the primary and secondary coils, as well as to secure complete circulation of the oil which is generally used in these transformers, in and about the coils, core, and connections. As regards exterior connections, which are of great importance in assuring the safety of the transformer, this type is equally strong. The flexible cables which form the leads are brought out through long porcelain sleeves and the secondary wires are well separated from the primary wires, so that the danger of leakage of primary current over the surface to the secondary wiring is obviated. The relative position of the terminals for the two windings is plainly shown in the illustration and speaks for itself.

Few commercial transformers show so great regard for safety in the placing of the leads or such thorough precautions to prevent the chance of accident. Simplicity of construction and the ease with which all safety precautions can be carried out are excellent guarantees of long and useful life, which means to the operating company both safety and economy—safety not only from serious accidents resulting from bad insulation, but safety from interruption of service, which from the standpoint of dividends is almost equally important, for no company which does not furnish reliable light can expect profitable patronage. It is necessary indeed sometimes to take some chances in the overloading of machinery and transformers, in order to secure this continuity of service, and the importance of having a thoroughly well made

and well insulated transformer which does not run hot, and which can be depended upon to stand up under all sorts of strenuous conditions, cannot be over-estimated.

The shape of the magnetic circuit in the Type H transformers (a long rectangle of interlaced straight strips of iron), is such as leads both to a very simple and effective form of winding the coils, and to an economy in the use of magnetic material which permits a more liberal cross section of copper than is usually found in transformers, thus keeping down the heat generated in the transformers and both permitting the carrying of steady and heavy loads, and preventing the deterioration of insulation under the effect of long continued high temperatures. In respect to these most important properties with regard to durability and certainty of operation, Type H transformers challenge comparison.

The illustrations of the larger sizes of Type H transformers show also the existence of the same valuable characteristics. To certify to the care and thoroughness with which these transformers are insulated, it is only necessary to say that the insulation between primary and secondary is required to stand successfully a test at 10,000 volts alternating for all sizes of transformers and all primary and secondary voltages and on the average a pressure of more than 15,000 volts alternating is required to break down this insulation, corresponding to the maximum voltage of nearly 25,000 volts. To insure certainty of the primary and secondary coils being properly insulated, each transformer is tested, while running hot from its full load, at three times its normal voltage so as to break down and detect any weak points in the insulation. These tests are the severest to which any commercial transformers are put, and the transformer which successfully stands them can be counted upon to do good and efficient service under all ordinary and extraordinary conditions.

Make the insulation between primary and secondary ever so good, there is always a possibility of its giving way under unusual circumstances. Serious overload may char the insulation or it may receive mechanical injury, and even in the best condition it may be pierced by lightning.

While the Type H transformer with its substantial insulation (consisting quite largely of mica between cylindrical surfaces), insures a transformer of the greatest possible reliability, yet the question is often asked—"Can a transformer be made which will absolutely prevent any possibility of a high potential current existing on the secondary circuit?"—To this is replied, that by the use of a so-called "Ground Shield," absolute safety to life or property can be assured. The ground shield consists simply of a sheet of copper covering the entire surface which the secondary winding presents to the primary winding. If this copper sheet is connected to the ground by means of a wire it is perfectly evident that it is impossible for any greater difference of potential to exist on the secondary circuit than that for which the secondary is wound, even should primary and secondary be in actual contact with the sheet.

Other things remaining the same, there must be slightly increased danger (in a transformer provided with such shields), of the insulation being damaged by lightning in its effort to reach the earth, yet experience, which includes one installation of 250 to 300 such transformers situated in a district peculiarly subject to lightning disturbances, shows no appreciable increase of such trouble. It might be added that one prominent fire insurance company already requires that all transformers furnishing current within property insured by it shall be provided with this protective device.

The General Electric Company early recognized the value of immersing transformers in oil, and since January 1, 1891, has constructed its transformers with boxes adapted to its use. While some transformer manufacturers recognize the value of this feature, and will upon special order provide boxes suitable for holding oil, the General Electric Company is the only American manufacturer that makes an oil-tight box standard practice.

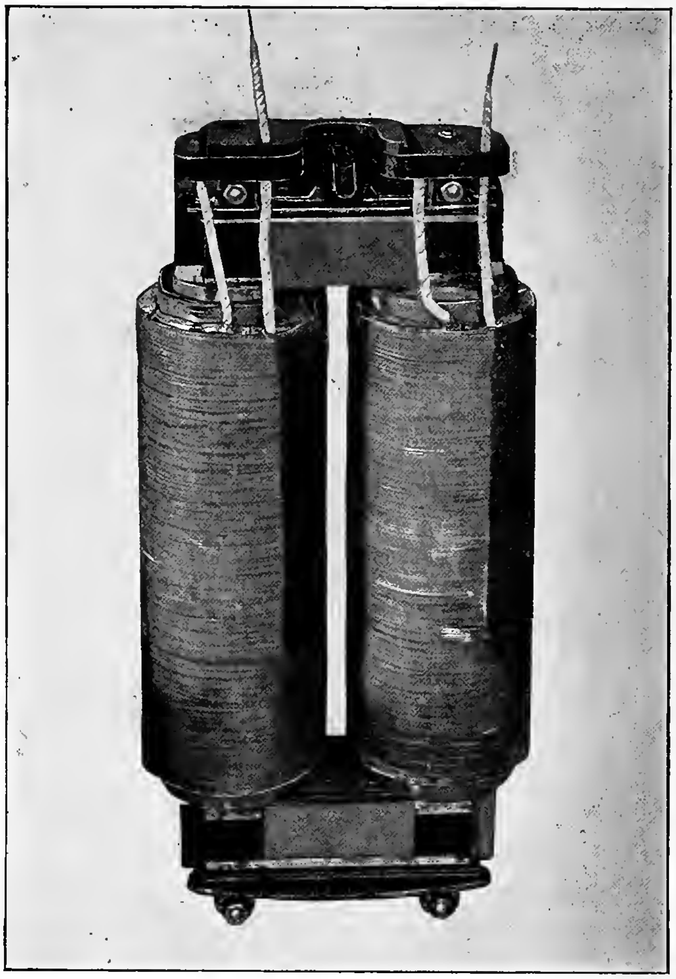
Oil in a transformer serves three distinct purposes:

1st. It increases resisitance against breaking down of the insulation and re-insulates punctures in the insulation.

2nd. It reduces the temperature.

3rd. It preserves the insulation from oxidation.

In regard to the first item,—a potential that will jump through one inch of air, will jump only about one-fifth that distance in most pure oils, and it must therefore be evident that if the small air spaces about and between the mechanical insulation of a transformer are filled with oil rather than air, the resistance to breaking down of the insulation must be markedly increased by the presence of the oil. Not only this, but should the insulation be pierced by a high potential discharge, the oil will flow into the puncture and in a great measure re-establish the insulation. Insulation is perhaps fully as often injured by a discharge of a small charge on the line due to the "atmospheric electricity" or to a lightning discharge at a distance, as by a direct lightning stroke. The current from such a discharge is often very small and causes therefore no actual damage other than a minute puncture of the insulation between primary and secondary. Such a puncture when filled with oil does not greatly reduce the value of the insulation.



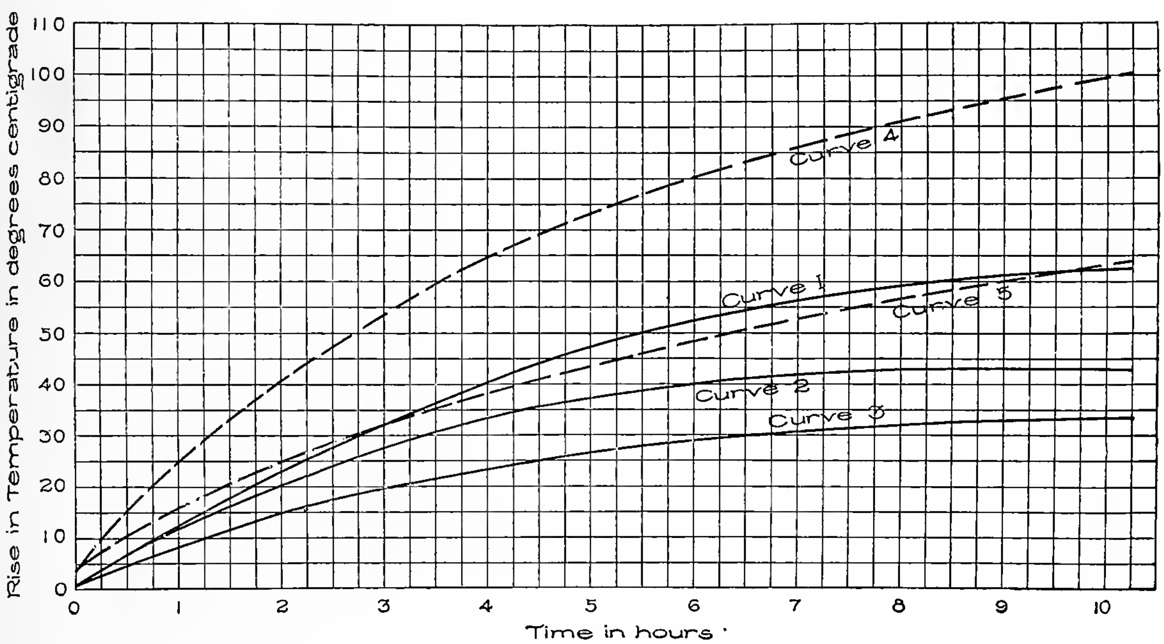
CORE AND WINDING OF TYPE H TRANSFORMER.

In regard to the second item,—most heat insulators such as asbestos, saw-dust, etc., prevent the transmission of heat because their structure is such as to enclose throughout their mass, minute particles of air. While the air between a transformer and the case and within the insulation is not confined nearly so closely as in the substances referred to, it cannot circulate freely enough to act as an efficient transmitter of heat. Oil is a much better conductor of heat than stationary air, and moreover, unless confined to very small spaces, convection currents will be set up and carry the heated oil to the cooler surface of the case. The above

curve sheet clearly illustrates these facts. Curve 1 shows the actual temperature by increase of resistance of Type H transformers; Curve 2—temperature of transformers containing oil; Curve 3—temperature of oil; Curve 4—temperature of same size transformers built by one of our most prominent competitors; Curve 5 —highest accessible thermometer temperature of the transformer whose actual temperature is shown by Curve 4.

This plainly points out how greatly in excess is the actual temperature as compared with any temperature that can be noted with a thermometer. Purchasers of transformers should therefore not be content with a statement from the manufacturer as to what is the maximum temperature of his transformer, but should insist on knowing the manner in which this temperature is measured.

In regard to the third item,—anyone who has dissected a transformer (having the rise in temperature common to small lighting transformers), after it has been in use without oil for a year or more, knows how very brittle and fragile the insulation becomes even within this short time. At quite moderate temperatures most insulation undergoes a slow process of oxidation that soon causes this undesirable deterioration. If, however, oil is used, the air has no access to the insulation and all oxidation is prevented and the



CURVES SHOWING RESULTS DUE TO USE OF OIL IN TRANSFORMERS.

insulation retains its original pliability, thereby indefinitely increasing its life.

While for the following reasons the use of oil is most strongly recommended, it must be recognized that at least in the case of small sizes of transformers there are sometimes well grounded objections to its use. Therefore all of the General Electric transformers are built so as to withstand the 10,000 volt insulation test, and all sizes smaller than 10 kilowatt so that they will run at perfectly safe temperatures when oil is not used.

EFFICIENCY.—As respects efficiency it is pleasant to note that in the past few years there has been great improvement in all transformers. In the early days of transformer practice, the low efficiency of transformers, even when full loaded, was a difficulty often encountered in the proper designing of alternating plants and often brought up against what was otherwise admitted to be a valuable and economical system. The early transformers of all makes left very much to be desired on the score of efficiency. The losses in a transformer are of three sorts,—hysteretic loss, eddy current loss, and copper loss. The last mentioned is comparatively difficult to avert since the specific conductivity of copper cannot be greatly improved by any practical manipulation, so that even in the earliest days of transformer building, good copper was available. Careful design, and the adoption of a better form has effected some improvement, but the greatest change in transformer manufacture has been in the improvement of the iron and the insulation against eddy currents. There is something most mysterious in the properties of iron with respect to magnetic change—not only do these properties vary in the most erratic way, from changes in chemical composition which can barely be detected by analysis, but they also vary in a most extraordinary fashion according to the treatment to which the iron has been subjected. Hence the securing of a proper quality of iron and its proper treatment are matters in which experience counts for everything, and a priori reasoning for very little. The only way to secure low iron loss and low core loss in transformer building is to obtain the best material which can be found and to treat it carefully and intelligently in the operation through which it goes prior to its appearance in the finshed transformer.

It is now a well recognized fact that the loss in a given body of sheet iron subjected to a definite number of magnetic reversals per second and at a definite density of magetization. does not of necessity always remain the same. It is only by the greatest care that iron is brought into the condition in which it gives a minimum loss when subjected to alternating magnetization, and the manner in which this result is obtained and the conditions to which the iron is subjected in actual use have both to be considered to insure keeping in this condition.

In the manufacture of transformers, failure to properly consider these facts will produce a transformer which may give a fairly low core loss when first produced, but which after being in use for a short time will give a core loss 25 per cent, 50 per cent, or even 100 per cent greater than at the start.

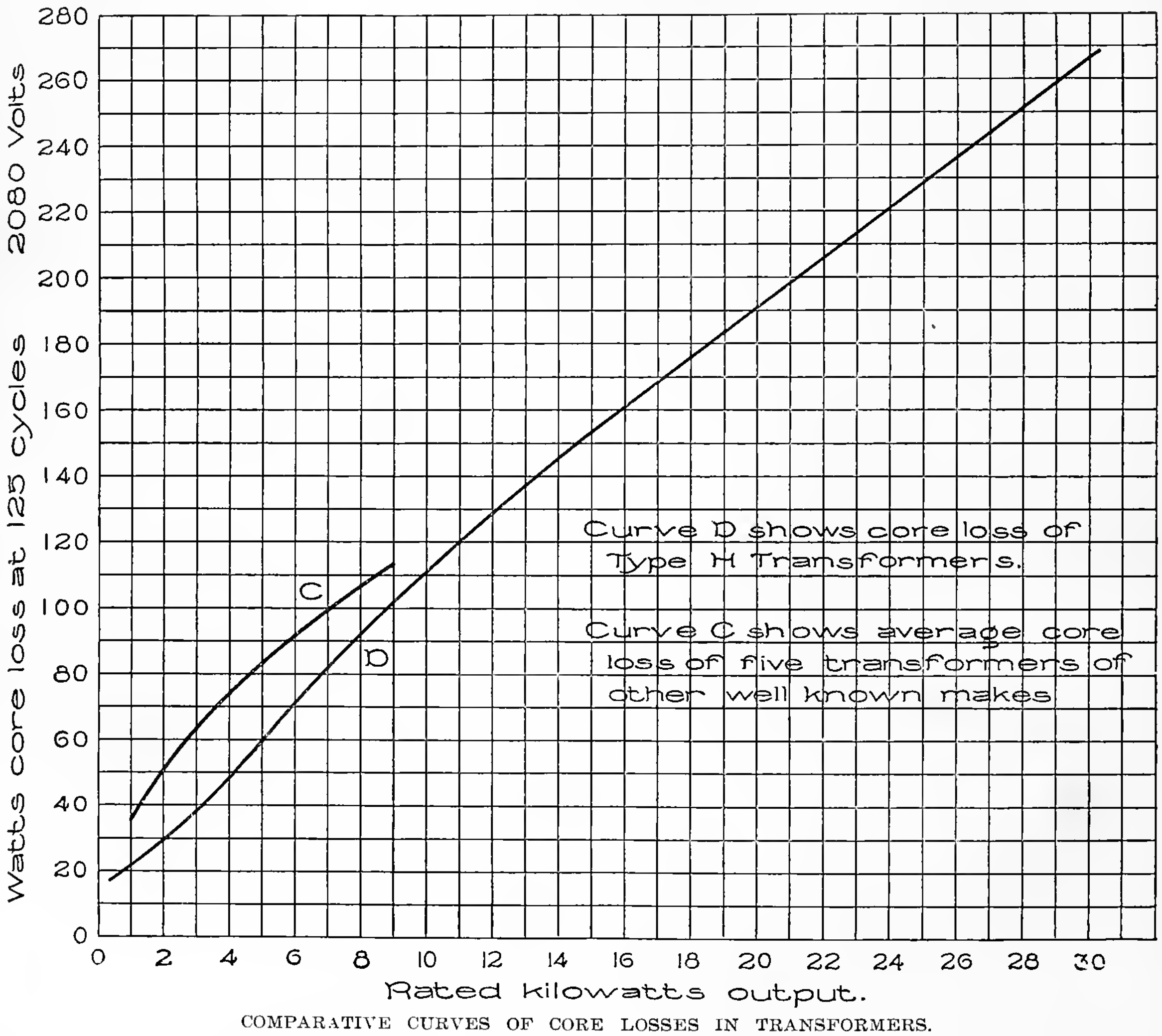
This phenomenon is popularly known as Magnetic Fatigue or Ageing. The General Electric transformers are practically free from this most serious defect; in most cases the core loss due to ageing is absolutely negligible and in extreme cases it is not more than 4 per cent on 5 per cent. On th accompanying curve, actual results obtained on a standard Type H transformer are given, which, it will be observed, come readily within this limit. There is also given as a practical illustration of this defect, a curve of actual results recently obtained on a 2,500 watt transformer of other well known make. At the time of last test the increase in core loss was, it will be seen, 68.9 per cent after a run of 90 days under normal conditions of commercial operation.

The improvement in the matter of core loss, even in skillfully designed transformers of the same make, owing to better facil-

ities for getting good iron, and greater knowledge of treating it, has been profound. The difference in core loss between the early transformers manufactured by the Thomson-Houston Company, and the Type H transformers, which have succeeded and will supersede them, is prodigious. The core loss in the early transformers referred to, from hysteresis and eddy currents, is more than four times as great as is found to-day in the Type H transformers.

A large core loss of course lowers the efficiency of the transformer, and since that core loss is neary constant for all loads it lowers the efficiency most seriously at light loads. This is but a special case of the general theorem as to any mechanical or electrical apparatus. Constant losses cut down the efficiency more and more as the decreases because they are a greater proportion of the load. Consequently we find that in these old transformers low loads are the rule throughout the operation of the plant, and high loads the rare exception. This is an unfortunate state of things which has naturally resulted from the methods of installation followed in all the early plants, and in some recent ones. It has been almost universally the custom to install a transformer to supply the needs of each consumer. Now certain classes of consumers, in particular, shops, require most of their lights to be burning for only a short time during the evening, while for the greater part of the day no lights are used and only a few lights during most of the hours when lights are needed; consequently for the greater portion of the time the transformer is either operating under-loaded and subject to its steady core loss, or is very lightly loaded, and working, therefore, at a very bad efficiency.

Even more aggravated are the conditions existing in domestic lighting. A residence is usually equipped with lights in every



COMPARATIVE CURVES OF CORE LOSSES IN TRANSFORMERS.

while the efficiencies at all loads are inferior to the efficiencies of the Type H transformers, the efficiencies at low loads compare very much more favorably than those at high loads. For example, the efficiency of a Thomson-Houston, 1,500 watt Type E transformer at full load, was 92 per cent. The Type H transformer of the same size has at full load, an efficiency of 95.9 per cent, but at one-quarter load, where the latter transformer still has an efficiency of 92.5 per cent (greater than that of the Type E transformer at full load), the Type E transformer had an efficiency of but 79 per cent, and was better than most of its contemporaries, and as good as most of the cheaper transformers put on the market to-day.

Efficiency at low loads is one of the most valuable properties which a transformer can possess, because it unfortunately happens that in most of the alternating practice up to the present time, room, and at times all the lights, or nearly all of them, are likely to be in use, so that the transformer capacity must be great enough to take care, in such an emergency, of all the lights installed. Nevertheless for the most part the transformers used for residence lighting are exceedingly lightly loaded, perhaps only half a dozen lamps may be burning out of twenty-five or thirty installed. Consequently the transformer is working at one-quarter load or less from one year's end to the other with occasional rare exceptions. Under these circumstances a high efficiency at light load is absolutely necessary for the preservation of decent station efficiency and proper returns from the investment.

In the early days of incandescent lighting, when lights were habitually installed by contract, one could count on most of the lights installed being used, so that the worst which could happen was the installation of a large number of very small transform-

ers. Now when electric lighting is almost universally metered, the number of lamps installed is relatively much greater than under the old regime, and therefore while nearly the same number of transformers have to be installed, these transformers have to be proportionately somewhat larger than the former, and consequently are relatively more lightly loaded, and run relatively less efficiently, so that with the practice of metering it becomes doubly essential to use transformers which are of high efficiency, not only at full load, but at light load, at which they are likely to be run, and in which the core loss is so small that when the transformers are entirely unloaded the amount of energy wasted in them shall be a minimum.

It was with this particular point in mind that the Type H transformers were designed and are being put upon the market. They are actually of higher efficiency at one-quarter load than are a large proportion of the commercial transformers now in use, at full load. The effect of this enormous improvement in economy of operation of the station can hardly be over-estimated, and we will look into it carefully later. It is sufficient here to note that the core oss in these Type H transformers is from one-third to one-half less than is found on the average in recent transformers of other good makes. This is not unnatural, since low core loss was one of the essential properties with reference to which these Type H transformers were designed.

This superiority of the Type H transformers is shown in no way more strikingly than by the following curves. The curve D shows the total core loss in the different sizes of Type H transformers up to 30 kilowatts, and the curve C, plotted on the same scale, shows the average core losses of five transformers of other well known makes as represented, not by ex-parte tests, but by the claims made by the respective manufacturers.

Personal

Mr. John Martin has gone East on a business trip and will probably be absent thirty days.

Mr. C. S. Knowles, of the "Seven Arch" street electrical supply house in Boston, was in Southern California during the latter part of June.

Mr. Edgar C. Gribble has been appointed to the position caused by the death of Mr. John R. Regan, late Chief Electrician of the Palace Hotel, San Francisco.

Mr. John B. McKilligan has resigned the general managership of the Victoria, B. C., Street Railway & Lighting systems to enter his own business as Mining, Real Estate and Financial Agent at Kalso, B. C.

Mr. E. T. Pardee, of the home business office of the Fort Wayne Electric Corporation, has reached San Francisco and will be located in the Pacific Coast Agency of that concern for an indefinite period.

Mr. C. O. Poole has been promoted to the vacancy caused by the resignation of Mr. E. A. Roe from the Superintendentcy of the Electrical Department of the San Francisco Gas & Electric Company. For several years Mr. Poole has been in charge of the Townsend Street Station and his promotion elicits satisfaction on every side.

Mr. Edward A. Rix has retired from the Rix Compressed Air Machinery Company and will hereafter engage in business independently as the Rix Engineering and Supply Company, handling both electrical and pneumatic machinery, with permanent offices on the second floor of the building on the south east corner of First and Market streets, San Francisco.

Prof. R. B. Owens, of the Department of Electrical and Steam Engineering of the University of Nebraska, has been placed in charge of the Department of Electricity of the Trans-Mississippi Exposition and his appointment insures the overwhelming success of the electrical section for his personality is the embodyment of the chief attributes of success.—unquestioned ability, unlimited energy, practical experience and personal popularity.

Educational

VAN DER NAILLEN GRADUATES.

The Thirty-third annual list of graduates (1897) of the Van der Naillen School of Engineering of San Francisco, contains the following names in the Electrical and Mining Departments:

Electrical Department—R. A. Huntington, city; E. Nelson, city, S. S. Thompson, Billings, Mont.; B. Coffin, H. J. Wilson, city; R. S. Andrews, Honolulu; F. F. Dreschler, Port Costa; L. E. McKay, Oakland; G. H. Stockbridge, Los Angeles; George Vivion, Yuba City; N. McAuslan, Sutter, Cal.; C. Langerman, Yukon, Alaska; Thomas Oriel, Mexico; B. Miller, Grass Valley; A. R. Talamentas, Compton, Cal.; E. M. Reynolds, Lathrop, Cal.; F. Kinsman, city; C. Krasilnikoff, Siberia.

X Ray Department—O. W. Lutz, Napa; Elizabeth Fleishman, city; W. H. Hennessey, city.

Mining Engineers—G. L. Gruss, Genesee, Cal.; John Andrews, Middleton, Cal.; C. Maack, Petaluma; W. B. Duesler, Globe, Ariz.; E. Matterson, Shasta, Cal.; R. Trengove, Neuman, Cal.; R. Von Reischach, Antofogasta, Chile.

Obituary

JOHN R. REGAN.

It is with regret that announcement is made of the death of Mr. John R. Regan, of pneumonia, at San Francisco on June 18th last.

Mr. Regan was a Native Son of the Golden West, having been born in San Francisco in 1862. He entered the electrical business early in life, being one of the earliest of the employees of the Sutter street electrical supply house that formed one of the concerns which afterward developd into the California Electrical Works. While yet quite young, Mr. Regan went east and became associated with the original Sawyer-Man Electric Company, with which concern he remained until after its alliance with the Thomson-Houston Electric Company. His exceptional ability in the handling of workmen was the cause of his being placed in charge of the installation of the Patterson, N. J., plant and after it was in satisfactory operation, he returned to New York where he at once entered the service of the Harlem Electric Lighting Company, then controlled by the New York Electrical Construction Company. The supervision of construction seemed to be his penchant, however, for his next change was to Utica, N. Y., where he remained in charge during the construction of the Utica Electric Light plant.

It was about this time that the painful affliction of inflammatory rheumatism laid its racking hold upon him and for two years his sufferings were so great as to render him an invalid. Realizing that a marked change in climate would probably do him more good than anything else, he returned to California in 1890 and at once entered the service of the Electrical Improvement Company of San Francisco in the capacity of superintendent of incandescent construction. His return to health upon arrival in California was very rapid and the thoroughness of his work gave additional endorsement to the reputation he had already borne for ability in this direction. With the absorption of the business of the Electrical Improvement Company by the Edison Light & Power Company, Mr. Regan entered the service of the Palace Hotel as Chief Electrician, where he remained until his death and it is a fitting tribute that of the many who mourn his loss, the kindest words in his memory are those of former employers who early recognized him to be a man that was generous always, yet who never permitted personal friendships, relations or interests to interfere to the slightest degree with the execution of business.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

A DIVIDEND AND A BIG CONTRACT.

The Westinghouse Electric & Manufacturing Company, on Tuesday June 22nd, 1897, declared a regular quarterly dividend on its preferred stock of 1¾ per cent.

On the day following, the annual meeting of the stock-holders was held at the factory of the Company in East Pittsburg, Pa., the annual report of the Company was read, showing its condition to be prosperous. The Board of Directors of last year were re-elected, being composed of—August Belmont, Lemuel Bannister, Geo. Hebard, Henry B. Hyde, Marcellus Hartley, A. M. Byers, N. W. Bumstead, Chas. Francis Adams, Brayton Ives, and Geo. Westinghouse, Jr.

After the meeting, it was announced that the St. Lawrence Construction Company had, on June 18th, awarded to the Westinghouse Company, a contract for fifteen 5000 h. p. generators, which are to be erected at their plant at Massena, northern New York. This is the largest single order ever given for electrical apparatus and the amount directly involved is about three quarters of a million dollars.

This contract, together with that recently given by the Cataract Construction Company of New York, for five 5000 h. p. generators, for installation at Niagara Falls, N. Y., makes a total of twenty 5000 h. p. generators, having a total capacity of 100,000 h. p. which have been ordered from the Westinghouse Electric & Manufacturing Company this year.

AN EVIDENCE OF PROSPERITY.

It is a positive enjoyment to call at the new offices of Mr. John Martin, Pacific Coast agent for the Stanley Electric Manufacturing Company and of Fred M. Locke, where everything is homelike and inviting. These attributes are due to the agreeable personnel of the office and to the simple comfort of its furnishings, and no one need not feel at home there.

The new offices are located at 300 California street, on the north west corner in the building recently vacated by the Grangers' Bank. The offices are located on the ground floor and the basement of the entire building is used as a packing room and for the storage of the large stock of Stanley motors, transformers, instruments, etc., and of the Locke insulators and line materials, that is carried. The growth of business which necessitated the removal of Mr. Martin's agencies to such well-appointed offices, bears testimony to the popularity and merit of the apparatus there represented.

Mr. John R. Cole, of 115 New Montgomery street, San Francisco, announces that he has secured the agency of the Cutter Electric & Manufacturing Company, of Philadelphia, manufacturers of the well known "C. S." Flush switches, and the "I. T. E." (Inverse Time Element) Circuit Breakers for both alternating and direct currents.

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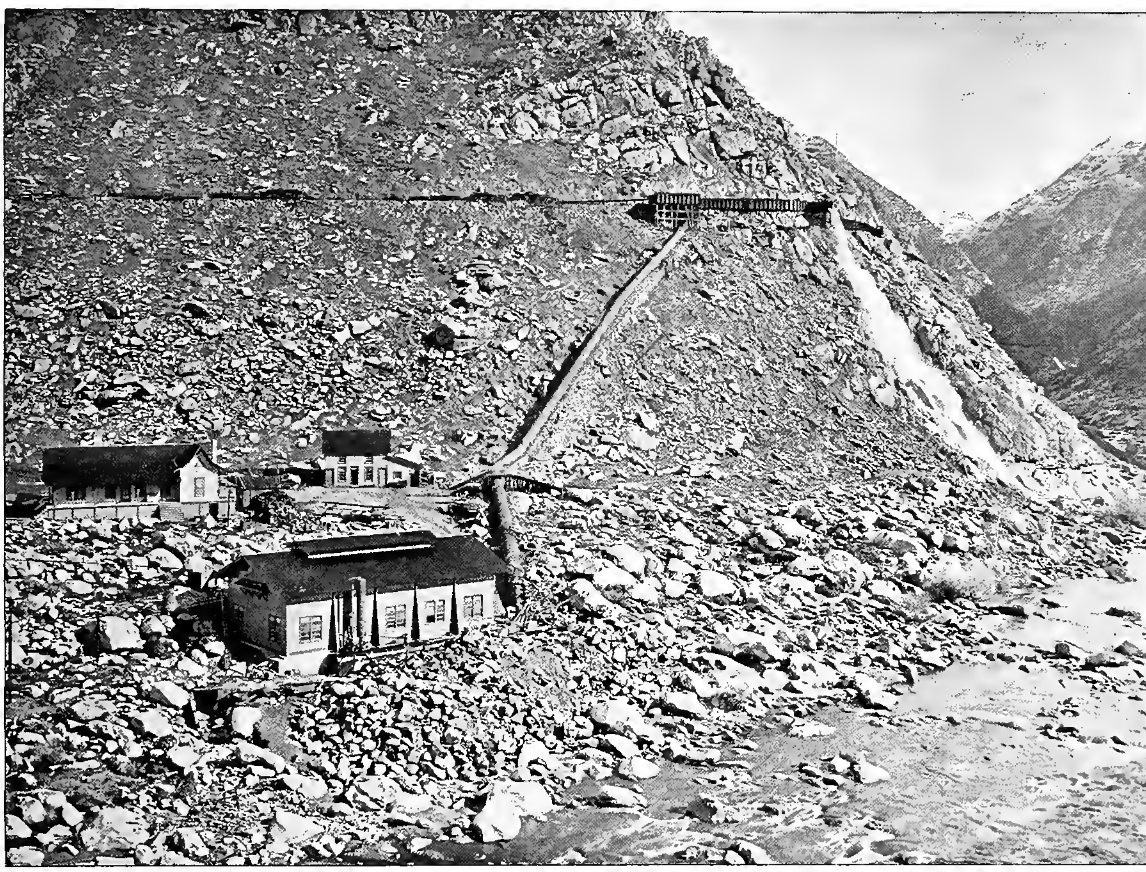
The Bakersfield Transmission.

The announcement that a trip to Bakersfield and an examination of the electrical transmission plant of the Power Development Company, which is there located, is to be undertaken, brings forth from those who have been there in summer uncomforting tales of a particularly torrid climate. The habitual story teller will drag from his grab bag of drivelling reminiscences, well worn yarns of the time he spent in Yuma and tell you that in Bakersfield too, hens do not set on eggs to hatch them, but to keep them from baking, while, if he be an engineer, he will solemnly vouch for the truth of tests he has made of steam boilers in Bakersfield from which it was conclusively proven that with picked coal and trained firemen, it was easily possible to attain an evaporation of 30 pounds of water from and at 208 degrees F. in a water tube boiler with a consumption of three-eighths of a pound of coal, provided the top of the boiler was exposed to the sun. Another story teller will probably relate that the Bakersfieldian on reaching Hades, found blankets to be of no comfort until after he had stimulated his circulation with a horn of tobasco. Then too, the bleak granites of the great canyon of the Kern river, it is said, harbor centipedes and scorpions and rattle snakes in every crevass. and so unalluring were the prospects extended that it must be confessed the journey was undertaken with a mild sort of abandon-hope-all-who-enter enthusiasm.



AT THE GENERATING STATION OF THE POWER DEVELOPMENT COMPANY.

None of these stories are of course any more true than was the equally solemn assertion that in Kern county thermometers are built horizontally because it is impossible to make them high enough to record the temperature there. In midsummer the weather is hot,

to be sure, but the visitor will not find it unbearable if discretion be used in matters of dress, of exercise and of diet.

Until the completion of the Valley Road into Bakersfield, the best way to reach that city from San Francisco will be to take the Southern Pacific Company's night train leaving at 5 p. m. and scheduled to arrive at Bakersfield at 4.30 a. m., but the schedule is generally a bit of fiction, for the Southern Pacific Company

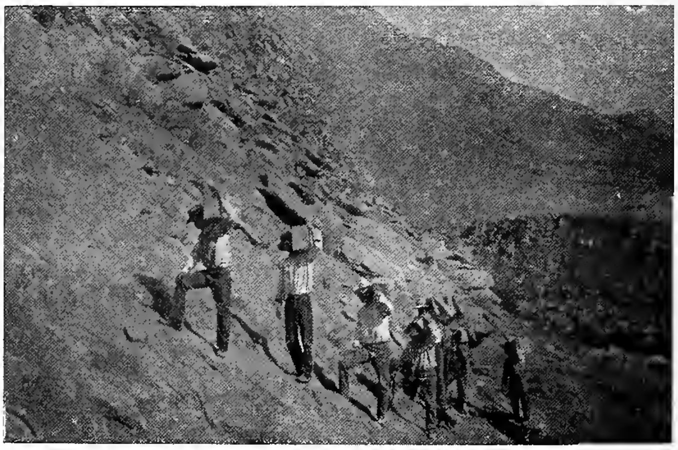
THE FLUME GRADE AND THE KERN RIVER.

makes no attempt to regain lost time, and the traveler soon becomes convinced that with the S. P. Co. it is, "once late, always late." It is best to start at once for the power house before the sun rises high, always provided, of course, that your train graciously condescends to sanction your arrangement. The roads are good and in about two and one half hours the visitor should be at breakfast at the cosy cottage of the company at the generating station. This is located right at the mouth of the Kern River canyon, where from out the rolling foot hills abruptly rise to an elevation of 1300 feet higher, the wild rugged granites forming the very edge of that portion of the Sierra Nevadas. One marvels at the rockiness of these surroundings and is astonished to learn that the power house site, consisting of a trifle over two acres of ground, cost the electric company ten thousand dollars, and that the clearing of the ground for the power house and buildings cost over $4100 additional.

In countries where water is less prized than in Kern county, the Kern river would be called a creek in summer, for it is but a mountain stream, even though a large one. At times it is torrential and at other portions of the year, neary its entire flow will be diverted into the flume. The bleak rocks carry very little soil between them, hence except in the spring, the mountains are almost totally without verdure of any kind, while high above them great eagles soar continually. Gray squirrels, jack rabbits and cotton tails abound; cayotes and wild cats are occasionally seen, while in a small grove of trees, less than two miles above the power house, deer may be found at any time, but the canyon is a government reservation and the deer remain inviolable. One day a large buck fell into the flume near the point to diversion. He swam down the water way and was swept out over the waste gate near the forebay, meeting death in the fearful plunge of 200 feet over the sharp jagged rocks that form the side of the canyon.

There is neither dam nor ditch at the in-take of the flume. The diversion of water from stream to flume is direct and merely consists of a channel formed by blasting out the boulders. The flume itself is a difficult and hazardous piece of engineering and the troubles attending its constructions were due to the solid granite formation of the mountain, to its almost precipitous sides, its extreme irregularity and to the constant danger of rolling boulders and land slides of disintegrated rock. The completed structure, nevertheless, is a substantial water-way built on very solid foundations and thoroughly shored. All curves have a uniform radius of twenty-five feet and the longest continual straight stretch of flume has a length of 210 feet.

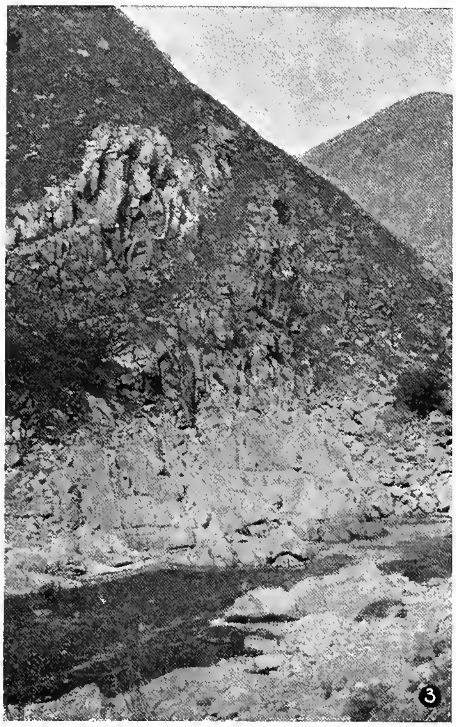
Every precaution has been taken to prevent accident to the flume from rolling boulders and rock slides and even the whole mountain side for a length of 10,000 feet and for an elevation varying up to 1200 feet was gone over by men with crow bars, who rolled down every loose boulder, but the action of elements and the disintegration of the granite by the atmosphere work changes that necessitate constant watchfulness. For hundreds of feet the flume graders were held suspend-



CARRYING DYNAMITE UP THE MOUNTAIN.

ed by ropes from the rocks above while they drilled for blasting, but not a serious accident occurred during the entire work. Some idea of the amount of blasting required will be had when it is known that while the length of the flume is less than 8800 feet, nearly fifteen tons of dynamite were consumed in blasting for the flume grade.

Eternal vigilance is always the best assurance of uninterrupted service in every flume, and in addition to



THE VIRGIN CANYON.

the constant inspection that the water-way of the Power Development Company is subjected to, it is thoroughly equipped with appliances, some new and novel, for further minimizing the possibility of interruption. About 200 feet from the head of the flume is located a trip gate. This device, which is either manual or automatic in its action, consists of a vertical flashboard gate, held in suspension across the flume above the water line by means of an electrically operated trip or trigger device. The gate is faced with narrow removable flashboards so that when closed the flashboards may be easily removed, thus relieving the pressure of water and enabling the gate to be opened by one man. Along the entire length of the outer side of the flume near its bottom, are run two No. 16 soft drawn bare copper wires, forming the circuit supplied with current from ten cells of gravity battery placed in the power house and controlling an iron clad electro-magnet that holds a ten pound sledge hammer in suspension. This magnet is 4½ inches in length and consists of a wrought iron core, having a diameter of 1 1-16 inches, about which is wrapped one-half an inch thickness of No. 22 cotton covered magnet wire. The whole magnet is then sealed in a piece of two-inch iron pipe forming one pole, the core being the other pole, while the face of the sledge hammer constitutes the armature or keeper of the magnet. Normally the gate is held in suspension by a trip lever and the sledge is held in suspension by the electro-magnet, but on the occurrence of the open- or short-circulating of the bare copper flume circuit, the magnet releases the sledge which drops on the trigger actuating the trip that releases the gate which falls and closes the flume. At the same time an alarm of notification is rung in at the power house. The advantages, not to say necessity, of some such controlling contrivance is impressed by the knowledge that a break in the flume if unchecked would cause great damage by washing out foundations and the flume patrol has thus, moreover, instant control over the head gate from all parts of the flume, and even from the power house. To close the trip gate, it is only necessary to either break or short circuit the light bare copper flume wiring.

A SIDE GATE.

At first, it will probably appear that the trip gate equipment introduces an element of unreliability into the system, but the details have been so carefully worked out and the circuits have been so located that accidental actuation seems almost impossible. From the battery the circuit continues through a signal board, giving constant visual indication of the condition of the battery. If the battery is permitted to run down a point of depletion is reached when an alarm will be rung in, but the

AFTER A BLAST.

magnet will, nevertheless, continue to hold the sledge in suspension until the potential applied has been reduced below three volts. From the potential indicator the circuit passes through two ordinary telegraph

relays in multiple before going to line. These relays have respectively front and rear secondary contacts, either controlling the alarm circuit, the former being actuated by the short-circuiting of the line and the latter either by its open-circuiting or the weakening of the battery. The inception and installation of the trip gate equipment is due to Mr. C. N. Beal.

Details of the flume construction are subjoined in the appendix hereto. In general, the flume is built of selected coast redwood free from knots and which was

HEAVY WORK AHEAD.

sawed on the ground in order that the timber would not be injured in transportation. The flume is double-lined and contains throughout between each of the board linings, a thickness of heavy P. & B. building paper applied with hot asphaltum at the seams and which alone insures water proofing.

Referring to the general view of the power house, pipe line and canyon on a point of the flume about midway between the forebay and waste gate, is located a water gauge for showing the height of water in the flume. The characters on the gauge are discernible to the naked eye from the power house by day, but at night the gauge is illuminated by incandescent lights, there being a white lamp at each foot mark and the traveling index carrying a blue lamp. The lamps are controlled by a switch placed in the thermometer house—colloquially termed "the weather bureau"—which is at the entrance of the station.

About 200 feet below the trip gate is a sectional trap gate placed at the bottom the flume for draining the flume and for relieving it of such water as may leak through the head trip gate when closed. A short distance further down is located the sand trap, consisting of an adjustable opening in the bottom of the flume at the lower end of a fifty foot section which has its bottom seven inches below that of the rest of the flume. At various points along the flume are located three side gates of usual form, while close by the forebay are a spill way and waste gate as shown in the general view. Equi-distant along the flume are four telephone booths leading to each other and to the power house.

The pipe line has a length of 540 feet with an inside diameter of 66 inches and at very reasonable velocity of flow it has a capacity exceeding 2000 horse-power. It was specially designed to meet existing conditions and an inspection by the writer of its entire length failed to discover a single leak. The pipe after being laid was covered with a heavy coat of P. & B. paint and was then buried in earth well tamped-in with water, which made a solid and substantial bed. This earth filling completely covers the pipe except for about one-sixth of its circumference at the top..

Full specifications showing the detailed construction of the pipe line, receiver and accessory equipments are appended to this article, but it may be stated that attached to the receiver are three cast iron saddles whose outer openings stand at an angle of 45 degrees from the center line of the receiver and to which saddles are attached three goose necks, two of which lead to the water wheel units, the remaining one being provided for a future extension. Each water wheel set is provided with a twenty-inch gate operated direct by an hydraulic cylinder as shown in the illustration on page 95. About midway between the forebay and receiver there is placed in the pipe line a 10 inch by 16 inch man-hole and at the two points of highest elevation in the pipe line are placed air valves which automatically open on emptying the pipe and automatically close on refilling it. As stated, the effective head is approximately 192 feet.

The prime movers consist of two sets of 44-inch Girard water wheels, each set containing two independent

LAYING THE PIPE LINE.

wheels as clearly shown in the illustration appearing on page 91. These wheels are direct connected with each other and with the generators, the exciter for each combination being driven from the governor fly wheel which weighs 6000 pounds. The gates are controlled by hydraulic rams as shown, while the governor, which is about to be described, actuates a similar ram that controls the seven nozzles of each wheel of the two sets and at the same time opens or closes as the case may be, a compensating by-pass valve, the

rear of which is shown in the illustration just beyond the main valve. These wheels run at 257 revolutions per minute and the decided novelty in the water wheel equipment consists in the governor. On page 95 is presented an outline sketch of the Girard governor, the action of which will be understood from the following description, which is here published for the first time:

To the person acquainted with steam engine practice the governor appears to be an ordinary form of shaft governor, but a closer inspection will show that it is in fact a transmitting power dynamometer as well as speed regulator and that the positions assumed by its elements are determined by the load passing through it, as will now be briefly outlined.

Referring to the drawing on page 95, the water wheel shaft A extends for a short distance into the hub of the fly wheel M and is a free fit therein. The fly wheel M is attached by insulated flange coupling direct to generator shaft, and consequently always revolves therewith.

On the water wheel shaft A is keyed the double crank B, having at the extremities of its two arms the crank pins C and C'; links D and D' connect the crank pins to the swing levers E and E' at the pins V and V'. The swing levers E and E' are attached by pins H and H' to the fly wheel M and have at their opposite extremities the adjustable weights F and F'.

Between the levers E and E' are strained the tension springs S and S', whose locations are at equal distance each side of the center line of the shaft A. At T and T' are stops attached to the rim of the fly wheel M to keep levers E and E' from drawing in too close to shaft A, and when revolved the outward throw of the levers due to centrifugal force is limited by the outer end of the levers coming into contact with inner surface of wheel rim, as shown at F'' in dotted lines. At L and L' are

WITHIN THE FLUME.

links which, being attached to bell crank levers (not shown in sketch), give longitudinal motion to a slip collar on shaft A and by a system of yoke lever and connecting rods, actuate the balanced valve of an hydraulic cylinder, which in turn opens and closes the nozzles and by pass valve as may be required.

The direction of revolution of the whole is shown by the arrow—and conditions of design and operation are such that levers F & F' are in position shown when maximum load is being transmitted at the predetermined number of revolutions per minute; and when no load is being transmitted they will take positions (as

THE SAW MILL AND LUMBER INCLINE.

shown in sketch for one of them by dotted lines F'') with their outer ends at the position of extreme throw. Intermediate positions will correspond to some transmitted load between no load and full load.

To make this more clear let us assume a governor as applied to regulate speed at 200 revolutions per minute and transmit from nothing to 200 h. p. Let the diameter of the circle swept by the pins H and H' be such that its circumference is 12.56 feet, then the force applied in the direction of a tangent to this circle as shown by dotted line x-y must be such that traveling 2512 ft. per min. it shall develop 200 h. p. or 2626 lbs., and as this force is transmitted through the two pins H and H' it must be of such intensity that its resultant in the direction x-y shall be 1313 lbs.—for each swing lever.

Suppose the design is such that the angle between the swing levers H and H' and this tangent x-y, giving the resultant direction of the force, is 30 deg. and that the distance from center of pin H to center of pin V is 7 inches, then 6 inches will be the distance between center of pin V and the force line x-y measured at right angles thereto.

Let the distance from the center of the pin V to the pin attaching link L to lever E be $13\frac{1}{4}$". Then we have $\frac{1313 \text{x} 6 \text{ in.}}{13.25} = 594.5 \text{ lbs.}$ as being net force which we must have acting radially outward from the above mentioned central point in order that full power may be transmitted through the dynamo-meter; to this must be added also the total initial tension of the two springs S and S' which let us assume as $305\frac{1}{2}$ lbs. Then the total centrifugal force of all the elements swinging about the point H' must be such that, when assumed as concentrated at the central point above-mentioned between the sprins S and S', it

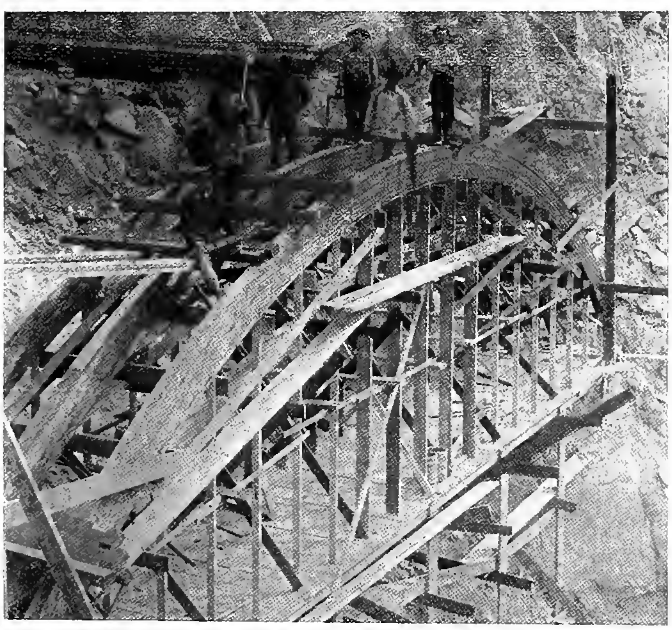
shall just equal 594.5 lbs. plus 305.5 lbs. equal to 900 lbs. and this central point will then be traveling, let us say, in a circle $34\frac{1}{8}$ inches in diameter, and all parts be in the position shown in the sketch.

Considering now the conditions when the swing levers are thrown to their extreme outward position by centrifugal force, the central point above mentioned will travel, let us say, in a circle of 13 15-16 inch radius, then a weighted swing lever which produced 900 lbs. centrifugal effect in the first case will now at the same number of revolutions per minute, cause a centrifugal force of 1040 lbs.—and the springs S and S' will each be increased in length $3\frac{3}{4}$ inches.

The springs S and S' are of such design and proportions that when having a fixed load of $305\frac{1}{2}$ pounds, an additional load of $734\frac{1}{2}$ lbs. will cause them to be extended $3\frac{3}{4}$ inches.

The results thus obtained are then as follows:

First—When all parts are in the positions shown in the figure and revolving at 200 rev. per min., 200 h. p. will be transmitted from shaft A to wheel M.



FALSE WORK FOR A FLUME ARCH.

Second—When revolving at 200 revolutoins per minute and levers H and H' are thrown out to their extreme positions, no power will be transmitted from shaft A to wheel M because in this position of the parts, the spring tensions and the centrifugal force of the swing elements are in balance and no force is transmitted along the swing levers E and E' to the pins H or H'.

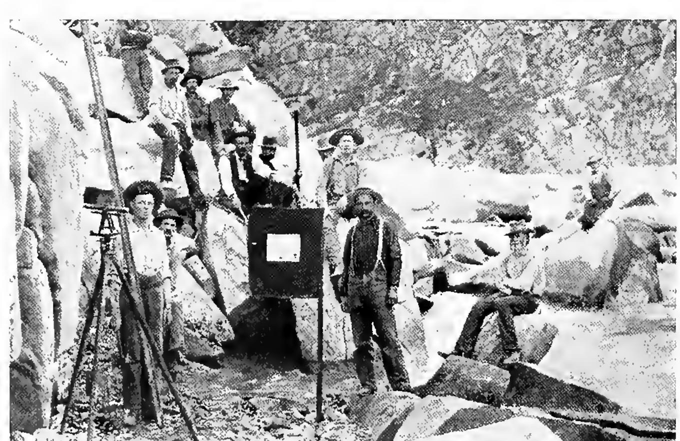
Third—As it is impossible for the springs S and S' to be of such proportions that practically equal extensions are produced by equal increments of load, it may be assumed that different positions of the swing levers H and H' between their extreme positions are measures of proportionate loads between no load and full load.

The rams controlling the nozzles and by-pass valves were originally actuated by water from the pipe line, but during certain seasons of the year the water is so gritty as to prevent satisfactory working from cut-

THE FINISHED ARCH.

ting the valves, and to avoid this the rams are now operated by oil under air pressure from the air chamber. Bolted to the base plate at the outer end of the rear side of each wheel set is a combination oil and air pump which is driven by belting and gearing from the main shaft. The ram discharges oil into a tank outside of the station and when the level of oil in this tank covers the orifice of the section of the oil pump, the oil is pumped into the oil receiver, and at other times the pump takes air which is forced into the air chamber.

Except in the matter of the sizes of units the electrical equipment of the power house does not differ materially from that of other transmission plants installed in California by the General Electric Company. The two 450 kilowatt units, which may of course be



THE GRADE AT WATER LEVEL.

run either singly or in synchronism, deliver current to their respective panels on the switchboard where they are connected to either of the two sets of bus bars through their main switches. From the bus bars current is carried to the two transformer panels, consisting merely of main switches and ammeters for each set of transformers. Separate ammeters are provided for each generator, for each bus bar and in the primary of each transformer set, the bus bar ammeters being placed at the top of the switchboard above the exciter panel. On this latter panel are located the usual exciter, ground detector, synchronizing and potential indicating apparatus so fully described in Mr. C. E. Dutcher's article on "Some Details of the Fresno Transmission Plant," appearing in the issue of the Journal of Electricity for April, 1897. Two General Electric multipolar, 125-volt exciters are used, each having a capacity of 17.5 kilowatts, and either being capable of exciting both generators and carrying the entire incandescent load for the generating station and buildings.

Dr. Cary T. Hutchinson, of the firm of Sprague, Duncan & Hutchinson of New York, who was selected as the consulting electrical engineer of the Power Development Company, made an exhaustive test of the appratus used before its shipment from Schnectady, and this being the first report by a competent and disinterested engineer on the efficiency and characteristics of this type of transmission apparatus avsalable, is here published in its essential features for the first time. The measurement of the general efficiency included the mechanical power delivered to the exciter, the efficiency of which was found to be eighty per cent. The commercial efficiencies of the generator were found to be as follows:

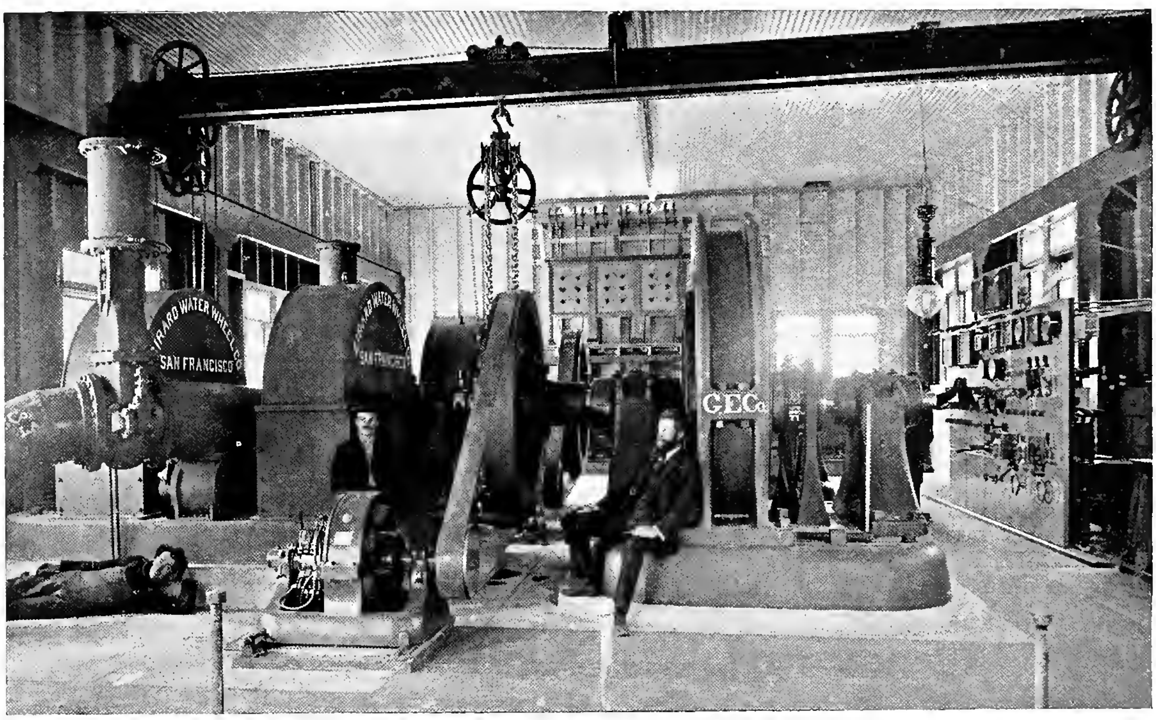
Full load	94.1 per cent.
Three-quarters load	93 "
One-half load	91.4 "

The generators were tested under full load for ten hours, and the rise in temperature was calculated from the increase in ohmic resistance and direct from thermometer readings. The insulation was measured by the volt meter method and by pplying a potential of 3,000 volts to the fields and 5,000 volts to the armature. The apparent anomoly in the field temperatures as determined by the resistance method, (15 degrees). and by the thermometer reading (24 degrees) is probably due to the thermometer being affected by the heat of the armature. The fields run very cool.

The report shows the heating of the armature to be 47 degrees Centigrade and of the fields, 15 deg. C. as calculated by the increase of resistance method, while the following readings show the rise in temperature above that of the air as recorded by the thermometer direct.

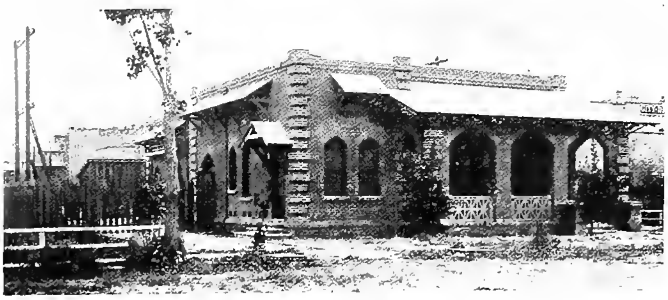
Bearing	17 deg. C.
Collector ring	30 deg. C.
Field coil	24 deg. C.
Leading pole tip	21 deg. C.
Trailing pole tip	23 deg. C.
Binding wires	51 deg. C.
Armature surface	43 deg. C.
Top of iron frame	10 deg. C.
Armature spider	32 deg. C.

The step-up transformer equipment consists of two sets of the General Electric type of air blast transfor-



INTERIOR OF THE GENERATING STATION.

mers, there being in each set three 160 kilowatt transformers taking the generator sixty cycle three-phase current at a potential of 500 volts and delivering to line a potential of 11,500 volts. The primary and secondary windings of both of these transformers are in delta, and a seventh transformer is at hand to use in emergency.

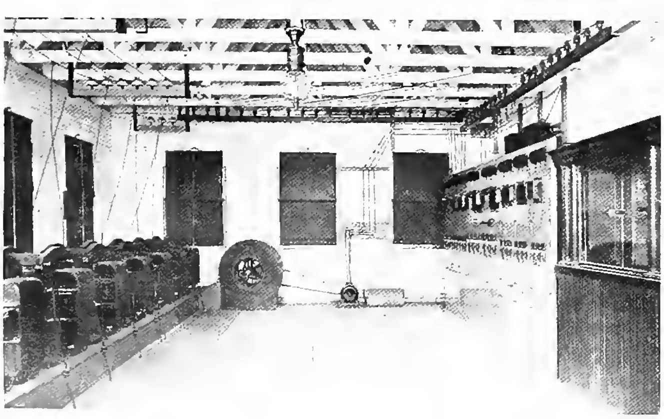


THE SUB-STATION IN BAKERSFIELD.

The transformers were submitted to a like exhaustive test which lasted under load for 4½ hours, the temperature being measured by the increase of resistance method.

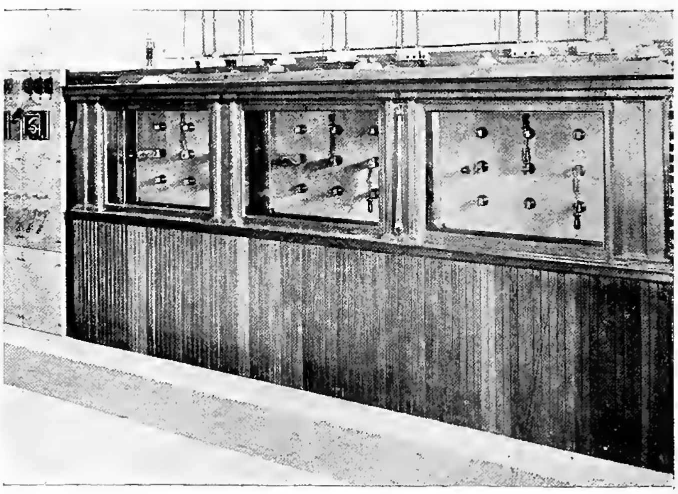
	160 KW	75 KW.
Primary	33 deg. C. average.	35 deg. C. average.
Secondary ..	32 deg. C. average.	32 deg. C. average.
Iron	22 deg. C. therm.	21 deg. C. therm.
Eff'y full load	97.4 per cent.	96.7 per cent.
" ¾ load ..	97.1 per cent.	96.1 per cent.
" ½ load ..	96.05 per cent.	94.8 per cent.
Eff'y ¼ load ..	92.7 per cent.	93.2 per cent.
" 1-10 lood	84.0 per cent.	83 0 per cent.
Core loss full volts,	3,200 watts average	2,050 watts average.
Magnetizing current,	.52 amperes	.375 amperes.
Power factor no load,	.53	.54
Insulation test ..	20,000 volts.	20,000 volts.

The connections on the high potential boards at the power house and at the sub-station together with the method of effecting local distribution at Bakersfield, form the most interesting departures in the entire electrical equipment. The details of the high potential switchboard at the power house are shown in the outline drawing on page 93, while those of the high potential switchboard at the sub-station appear on page 94. Panels A, B and C of the high potential board at the power house are clearly shown in the general view of its interior to consist of three sets of double pole, double throw switches, but the multiple panel, which is to the right of these three panels, is hidden from view by the frame of a generator. This multiple panel, however, merely consists of one set of triple pole single throw switches. All high potential switches used in the installation are of the familiar quick action type of the General Electric Company, having twelve inch breaks.



INTERIOR OF THE SUB-STATION.

Immediately below the circuit connections of these high potential boards in each of the drawings are shown numbered diagrams that afford the key to the combinations which may be effected. Of course it is understood that in making circuit combinations the switches must be in the same relative position on each of panels A, B and C, which correspond with legs A, B and C of the three-phase circuits. This holds true in both the power house and sub-station high potential switchboards, but the latter differs in appearance from the former in that it consists of but three panels, each being a set of triple pole double throw switches. In the generating station the transformer sets are on the switches and lines 1 and 2 are connected to the upper and lower switch contacts as shown in the outline drawing. In the sub-station, however, the lines are connected with the switches. The third line (that connected to the right hand switch of each panel) consists of an extension 10,000-volt circuit that is continued on from the sub-station for a distance of about ten miles beyond Bakersfield as will hereafter be described. This line, known as the Stockdale circuit, together with the two lines from the power house, form three high tension circuits that are connected to the switches of the primary board in the sub-station. The lines from the power house are designated as line 1 and line 2, while the knife clips leading to the sets of step-down transformers are shown as transformer 1 and transformer 2. The connections of the sub-station high tension board are clearly shown in the accompanying drawing.

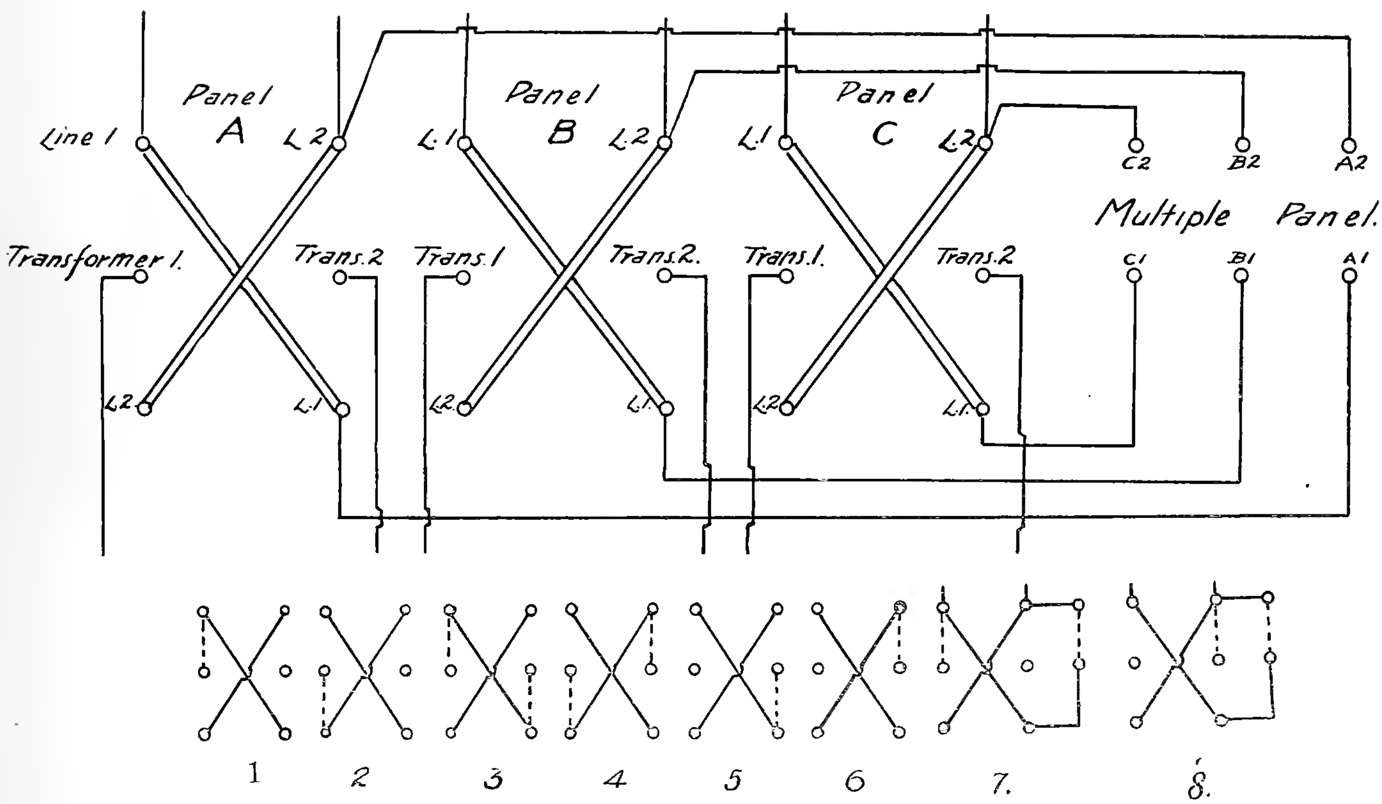


THE HIGH POTENTIAL SWITCHBOARD CABINET.

Reverting to the key of the high tension switchboard connections, the dotted lines appearing thereon show the different switch positions, and the number of the circuit connections, indicates like connections on both high potential switchboards. The various numbered combinations effect switchings as follows:

Combination 1. Transformer Set No. 1 on Line No. 1.
" 2. Transformer Set No. 1 on Line No. 2.
" 3. Transformer Sets No. 1 and 2 on Line No. 1.
" 4. Transformer Sets No. 1 and 2 on Line No. 2.
" 5. Transformer Set No. 2 on Line No. 1.
" 6. Transformer Set No. 2 on Line No. 2.
" 7. Transformer Set No. 1 on Lines Nos. 1 and 2.
" 8. Transformer Set No. 2 on Lines Nos. 1 and 2.
" 9. Stockdale Extension on Line No. 1.
" 10. Stockdale Extension on Line No. 2.

quate protection against lightning is of such importance that special attention has been given to it. The Bakersfield transmission plant contains arresters that are believed to be an improvement over those used in other transmission systems. As is becoming well understood, high potential currents are generated in overhead lines by disturbances of the atmosphere and these currents may be similar to direct currents, or may have high frequency like alternating currents. It is necessary to protect each side of the circuit with arresters as a simultaneous discharge from each wire causes a short circuit from line to line through the ground connection of the arresters, and a slight discharge of atmospheric electricity may cause a heavy flow of current from the alternators; this would be sufficient to



Connections of the High Potential Board—Generating Station.

Combinations 7 and 8 apply only to the generating station, while combinations 9 and 10 are applicable to the sub-station alone, and the particular criticism that may be applied to the high tension board in the sub-station is that it affords n means of feeding both sets of transformers from one line.

The design of the high tension switchboard as well as the innovation introduced in enclosing the high tension board in the sub-station, in the wooden cabinet as shown in illustration on page 92, is due to Dr. Cary T. Hutchinson, consulting electrical engineer of the Power Development Company.

From the high potential board the circuits proceed through the lightning arrester equipment before continuing on to line, and the problem of providing adequate

maintain an arc at the spark gaps in the arrester, destroying it.

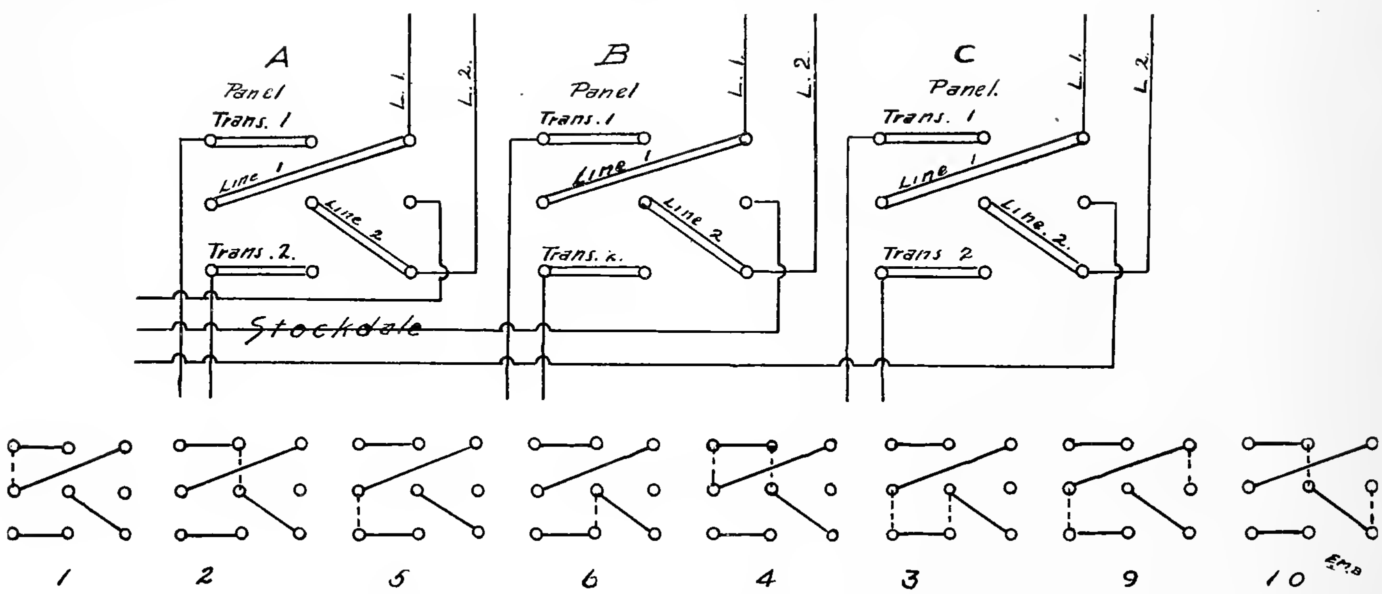
An arrester should therefore permit the passing of high potential discharges, yet prevent the line current from following such a discharge and maintaining an arc, and this is found to have been very effectually accomplished by the installation of a lightning arrester combination consisting of a series of brass cylinders, a comparatively high resistance ground circuit and a choking ring inserted in the main line. This, in brief, constitutes the Wirt arrester, which is used at Bakersfield. Each leg of each three-phase circuit has two marble panels on each of which are fifteen brass cylinders measuring two inches each way and separated one thirty-second of an inch. These two panels are

coupled in multiple and grounded through four graphite rods, each three-fourths of an inch in diameter, twelve inches in length and having a resistance of approximately 100 ohms. The resistance interposed in the ground wire is, therefore, about 400 ohms. From the high potential board the circuit continues through two rings, each about twenty inches in diameter and coupled in series with the line. Each of these rings contains about 150 feet of No. 4 cotton covered magnet wire which are well taped and independently supported on high tension porcelain insulators. The lightning arrester connection then is cut in before the circuit proceeds to line.

The pole line also affords an innovation from the conventional practice in high potential line construction, particularly in the use of short poles over the long distance of level, unfrequented territory traversed. Such poles in the Bakersfield transmission measure 10 by 10 at the butt by 6 by 6 at the top and

tension lines and the total length of the main line is approximately 76,000 feet or about 14½ miles. As stated, the Stockdale line continues about ten miles beyond Bakersfield, and as it is an extension of the 10,000 volt circuit, the total length of transmission of the Power Development Company is practically 25 miles.

Stockdale and Bellevue constitute the districts where nearly the entire output of the plant will be consumed. At the former is located the magnificent residence of Mr. W. S. Tevis and the extensive farms of the Kern County Land Company, while at Bellevue the farms and land of the Company are continued and extensive cold storage and packing houses are being erected. This section is noteworthy as being almost the only one of magnitude in a valley in California which presents the continual verdure that is common to Eastern localities during the entire summer. In California the verdure ordinarily disappears in summer but in this portion of the Kern River Valley it is



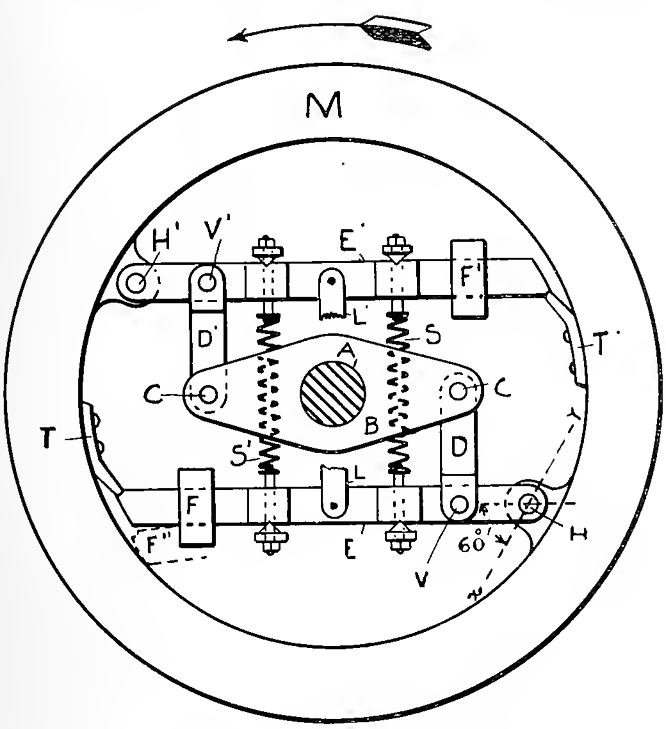
CONNECTIONS OF THE HIGH POTENTIAL BOARD—BAKERSFIELD SUB-STATION.

are only 26 feet long over all. They are placed 125 feet apart and carry two three-phase circuits of No. 4 B. & S. bare copper wire. The distance between wires on each side of the equilateral triangle of each circuit is twenty-four inches, the wires forming the apexes of the triangles, being on a short top cross arm, while the remaining four wires are on the lower and longer cross-arm. This construction is of far more pleasing appearance than that heretofore practiced where the reverse procedure was followed. The transmission is transposed at every mile, such transposition spans being but eighty feet in length, and the telephone circuit, consisting of No. 12, hard drawn bare copper wire, supported on glass insulators that are secured to the poles by wooden brackets at a distance of about three feet below the transmission lines, are transposed every third pole. Six-inch General Electric, triple petticoat, porcelain insulators are used throughout on the high

ever green owing to irrigation. The land company, however, owns hundreds of thousands of acres that are not irrigated, nor does the Kern river supply sufficient water for this at present uncultivated territory, and it is to the desire of the Kern County Land Company to irrigate this undeveloped domain that the Power Development Company really owes its existence. Although the soil is dry and parched at the surface an abundance of water exists twenty feet or so below and the most feasible means by which water may be pumped to the surface is afforded by the Power Development Company which has contracted to sell practically its entire output for pumping purposes to the Kern County Land Company. From a commercial standpoint therefore, the business of the Power Development Company probably presents the most favorable proposition upon which any electric transmission project is based. It has no bonded indebtedness;

it was built on a spot cash basis, and although it is at liberty to sell current to other parties, practically its entire output is contracted to a single consumer of the highest financial standing.

As stated heretofore the 10,000 volt line circuit merely passes through the high potential switchboard at the spb-station and is continued on to Stockdale



DETAILS OF THE GIRARD GOVERNOR.

and Bellevue, where a number of small sub-stations are being installed. These sub-stations are uniformly equipped with 15 k. w., special "type H" natural draft type transformers developed by the General Electric Company, in its long distance transmission work. In transformers of this type the primary coils, well taped and bound, are insulated from each other by thick layers of felt—in that shown the primary coils are eight in number. Between the coils of the primary and the secondary winding an air space of one-half an inch intervenes. The whole is mounted upon a solid iron foundation and securely braced, and is then covered with a corrugated iron cylinder provided with a ventilating roof.

From these transformers current is supplied for lighting and power purposes, the motors varying in size from two horse power to seventy-five horse-power, all being of the inductive type. The pumping stations consist merely of plain but substantial houses containing an induction motor driving a single centrifugal pump by a belt connection. The pump outlet emptying into an irrigating ditch of the usual form.

A retrospection of the plant of the Power Development Company impresses one with the careful study that has been given to effecting what may be termed practical refinments. At the power house, for instances, a studied effort has been to satisfy every reasonable desire of the employees. The cottage is a substantial, hard finished structure most conveniently arranged, furnished with unusually attractive fixtures and equipped with modern sanitry plumbing, while the sub-station is a perfect gem in the elegance and refinement of its polished oak and plate glass and tapestry furnishings.

The general direction of every detail of the installation of the transmission plant of the Power Development Company from its inception to completion has been in the complete charge of Mr. C. N. Beal, its Secretary and Treasurer. Dr. Cary T. Hutchinson of New York City designed and had charge of the electrical work and machinery, which was installed by the General Electric Company through its San Francisco office under the Chief Engineership of Mr. J. A. Lighthipe. The mechanical and hydraulic engineering has been handled by Messrs. Cobb & Hesselmeyer of San Francisco. W. R. Macmurdo of Bakersfield was the civil engineer in charge of construction and Walter James of the same place was consulting civil engineer. Chas. Webb Howard is President and W. F. Goad, vice-President of the Company, both being residents of San Francisco. Frank L. Whorf is Superintendent at Bakersfield, while J. F. Dearth and E. M. Beal are respectively the Superintendent and Chief Electrician of the power house.

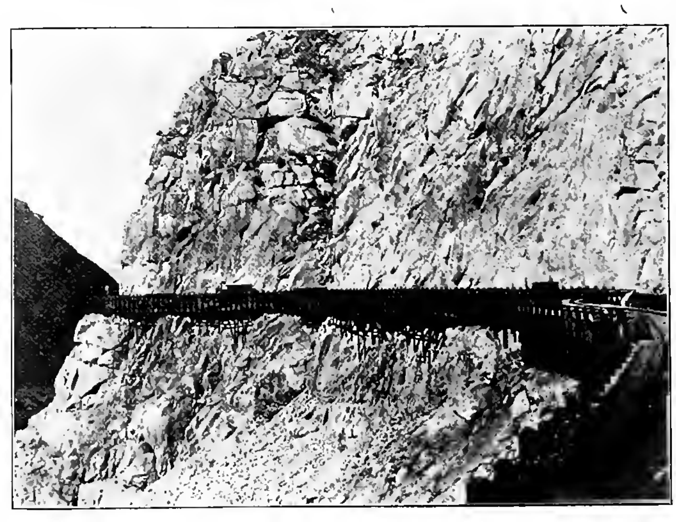
SOME DETAILS OF THE PLANT.

Following is presented detailed data concerning the plant of the Power Development Company:

THE FLUME.

Length	8,760 feet.
Width, inside	8 "
Depth, inside	6 "
Lumber used	967,360 "
Capacity	288 cubic feet per second.
Capacity	6,200 horse power.
Velocity of flow	6 feet per second.
Grade	5.28 inches per mile.

Weight of water per lineal foot, 3,000 pounds.



"OLD GIBRALTER."

PIPE LINE.

Diameter	66 inches.
Length of pipe line	541 feet.
Length of receiver	60 feet.
Maximum head to bottom of receiver	201.9 feet.
Effective head to nozzles	19.7 feet.
Pipe thickness	No. 12 B. W. G. to $\frac{3}{8}$ inch.
Maximum gradient	287 feet, of nearly 54 per cent.
Maximum velocity of water	6 feet per second.
Capacity	2,500 horse power.

RECEIVER:

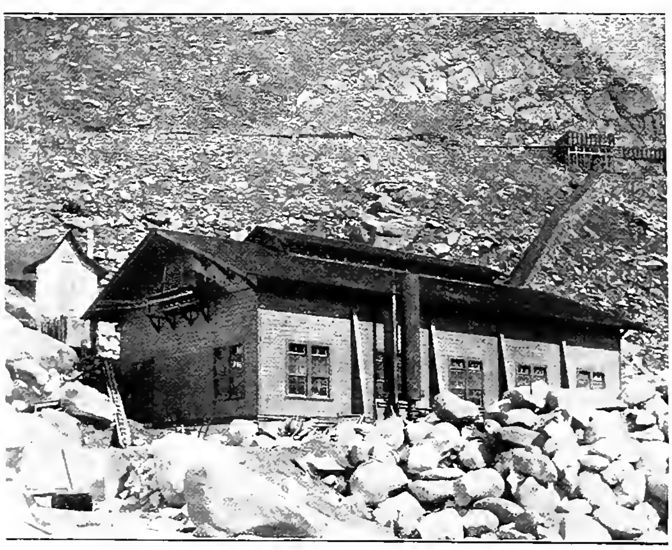
Length, 60 feet.
Internal diameter, 66 inches.
Materials, steel, 5-16 inches in thickness.
Circular seam laps, 3¼ inches.
Circular seam rivets, 64, ¾ inch.
Longitudinal seam laps, about 5 inches.
Longitudinal seam rivets, pitch, 3½ inches, double.
Distance between rows in longitudinal seams, 2 inches.
Bumped header of half inch steel with 10 inch by 16 inch man-hole in center.

Air chamber: 30 inch diameter by 16 foot length of Number 8 B. W. G. steel, connected to receiver by a 12 inch nozzle.

Charging tube: 6 inches in diameter by 16 feet in length of lap welded tubing and connected to receiver by 6 inch nozzle.

One 6 inch nozzle and blow off valve at bottom of receiver.

Lower end of pipe line carries a wrought iron flange to match similar flange on end of receiver. These flanges are made of 4 x ¾ welded wrought iron angle iron, faced for a gasket and drilled for 51, ⅝ inch bolts.



THE POWER HOUSE.

POWER-HOUSE EQUIPMENT.

Two sets 44 inch Girard water weels at 257 r. p. m., 1500 h. p.	
Two General Electric 450 kw., 28-pole, 550 volt 60-cycle three-phase generators, having 471 amperes per phase	900 kw.
Two General Electric 17.5 kw., 4-pole, 125-volt exciters at 1100 r. p. m.	35 kw.
Seven General Electric 160 kw., air blast, 500 to 11,500 volt transformers (I reserve)	160 kw.

THE POLE LINE.

Length of main line	76,000 feet.
Length of Stockdale extension	52,000 feet.
Size of poles, country division,	10''x6''x26' over all.
Size of poles, city division	12''x7''x40' over all.
Material of poles	Coast Redwood, sawed.
Distance between poles	125 feet.
Size of wire	No. 4, B. & S., bare.
Distance between wires	24 inches.
Transmission transposition	Every mile.
Telephone transposition	Every third pole.
Insulators	6 inch G. E. triple peticoat.

SUB-STATION EQUIPMENT.

7, General Electric 75-kw., air blast, 10.000 to 2080-volt transformers (1 reserve)	450 kw.
10, General Electric 15-kw., natural draft, 10,000 to 110-volt transformers	150 kw.

Transportation

THE POWER CONSUMPTION OF ELECTRIC RAILWAY CARS.

The following data, though deficient in many respects, is nevertheless interesting as showing the horse-power consumed by electric railways per car under various conditions of service. The Los Angeles and San Diego tests were made in 1893, while those of the San Francisco and San Mateo road were made during the latter part of the year following.

University Line of the Los Angeles Consolidated Electric Railway Co., Car No. 6; Brill truck, Westinghouse Gearless motor; Starting, 55.8 h. p.; Curves, 37.1 h. p.; Level at full speed, 19.9 h. p.

University Line, Car No. 101, Pacific Rolling Mill Double truck, Single reduction motor; Starting, 39.6 h. p.; Curves, 27.7 h. p.; Level at full speed, 17.8 h. p.

University Line, Car No. 9, Holmes rigged truck, single reduction motor; Starting, 39.2 h. p.; Curves, 28.2 h. p.; Level at full speed, 16.4 h. p.

West Lake Park Line, Car No. 4, Los Angeles, Brill truck, Single reduction motors; Starting, 44.3 h. p.; Curves, 27.5 h. p.; Grade, 53 h. p.; Level at full speed, 22 h. p.

West Lake Park Line, Car No. 3, Los Angeles, Brill truck, Westinghouse Gearless motors; Starting, 68.7 h. p.; Curves, 43.7 h. p.; Grade, 76.3 h. p.; Level at full speed, 23.5 h. p.

Vernon street Line, Los Angeles, McGuire trucks, Car No. 7, Sprague No. 6 Double reduction motors; Starting, 25.5 h. p.; Curves, 13.1 h. p.; Level at full speed, 5.7 h. p.

Maple Avenue Line, Los Angeles, Car No. 16, McGuire truck; Sprague No. 6 Double reduction motors; Starting, 22.3 h. p.; Curves, 9.7 h. p.; Level at full speed, 6.2 h. p.

San Diego, "Double Decker," two "W. P. 30" single reduction General Electric motors; Starting, 30 h. p.; Curves, 27 h. p.; Grade (5½ per cent), 35 h. p.; Level at full speed, 20 h. p.

San Diego double truck open cars, two "W. P. 30" motors; Starting, 27 h. p.; Curves, 23 h. p.; Grade, (5½ per cent) 30 h. p.; Level at full speed, 18 .h p.

San Diego single truck cars, one "W. P. 30" equipment; Starting, 20 h. p.; Curves, 17 h. p.; Level at full speed, 11 h. p.

Metropolitan Line, Baker street hill having a grade of 13.5 per cent consumed, 74 h. p., in a car equipped with two "W. P. 30" General Electric motors.

San Mateo Line; a loaded double truck car equipped with two "G. E. 800" motors, consumed 47.72 h. p., in

ascending the 9 per cent grade on Guerrero street between 26th street and Army street.

San Mateo Line; the double truck car as above consumed 67.5 h. p., in starting on the 7 per cent grade on Guerrero street, north from 22nd street.

San Mateo Line; in ascending the 7 per cent grade on Harrison street west from Steuart street, the following readings were recorded: 27 h. p., 55 h. p., 83 h. p., 86 h. p., and 62 h. p.

San Mateo Line; the Guerrero street hill of 11 per cent grade registered the following horse powers in ascending: 62, 69, 89, 85, 91, and 53 h. p.

San Mateo Line; Chenery street hill having a grade of 10.2 per cent showed a reading of 42.68 h. p., on the curve. To start on this hill showed power consumption varying from 80.43 h. p., to 85 h. p.

Gas

CHARACTERISTICS OF ACETYLENE.

Prof. V. B. Lewes gives the illuminating power of acetylene, as compared with other hydrocarbon gases, for the standard consumption of 5 cubic feet per hour, burned under one-inch water column pressure in the burner best suited for it, viz.:

Methane or marsh gas	5.2	candles.
Ethane	35.7	"
Propane	56.7	"
Ethylene	70.0	"
Butylene	123.0	"
Acetylene	240.0	"

The vitiation of the air in a room lighted by various methods to obtain the same quantity of light is manifestly less with the use of acetylene than by any other method. The extent of this vitiation is shown in the following table in which column 1 shows the cubic feet of gas consumed; column 2 shows the volume of carbonic acid produced from the consumption of gas as given, and in column 3 is given the number of adults in the room required to produce the same vitiation of air, viz.:

Coal gas flat flame No. 4	19 cu. ft.	10 cu. ft.	16.
Coal gas flat flame No. 5	22.6 cu. ft.	12 cu. ft.	20.
Coal gas flat flame No. 6	25.2 cu. ft.	13.2 cu. ft.	22.1
Coal gas argand	15.2 cu. ft.	7.9 cu. ft.	13.
Acetylene	1.2 cu. ft.	2. cu. ft.	3.6
Kerosene oil lamp	....	....	22.3
Sperm candles (40 used)	....	....	27.3

The flame of acetylene, notwithstanding its high illuminating power when burned pure, is distinctively a cool flame, approximating 1,700 deg. F., while an 18-candle power coal gas flame will be 2,200 deg. F., and in some cases higher.

TRAVELED OVER 600,000 MILES.

A peculiar anniversary was celebrated in Berkeley a few days ago by Charles Sterns, a motorman on the Telegraph-avenue line. For twenty-four years he has made daily trips between Oakland and Berkeley as stage driver, car driver and motorman, and during that time his travels have aggregated 600,000 miles.

THE PENALTY FOR BREAKING A CONTRACT.

An interesting case in the Supreme Court of New York was recently disposed by the discontinuance of the suit of the Okonite Company against Holmes, Booth and Haydens.

The complaint showed that in June, 1895, Booth and Haydens sold to the Okonite Company 300,000 lbs. copper at 12¼ cents, and after delivering 50,509 lbs., stopped further delivery. The Okonite Company then in September, 1895, purchased elsewhere the balance of the copper at 14 cents, and then sued Holmes, Booth and Haydens for about $4,500, the difference. Holmes, Booth and Haydens denied the contract. An order discontinuing the suit was entered in the Clerk's office on April 21st, and on enquiry it is understood that Holmes, Booth and Haydens paid the Okonite Company about $2,800 for a settlement.

INDEXING SCIENTIFIC LITERATURE.

Scientific knowledge is advancing so rapidly, that a comprehensive catalogue of current scientific literature is greatly needed by every professional man who wishes to know what is going on. An international committee, appointed for the purpose, has now arranged for the publication of a catalogue of this sort, to begin with the year 1900. It is to be edited by a central bureau in London, and will include every original paper on pure science, whether published in a periodical, in the tansactions of a society, or in book form. Applied science, however, will be excluded, because the undertaking is sufficiently vast without it.

THERE ARE OTHERS, ELECTRICALLY SPEAKING.

A Colusa tramp, after being told that a substantial breakfast would reward the faithful devotion of his energies to the sawing up of a wood pile, took refuge in "moving on" to the next farm, but not until he had left on the saw buck a scrap of paper bearing lines attesting a delicate fidelity to the sacred precepts of his profession.

The lines ran:

"Just tell them that you saw me,
But you didn't see me saw."

THE EXIGENCIES OF RURAL JOURNALISM.

Printer's Devil (from Bungtown Banner office).—Say, de editor wants yer t'pay up yer next year's subscription in Bromo Seltzer, an' let him have it right away!

Druggist.—Why, what's the trouble?

Devil.—Well, a feller paid three years' back subscription in apple jack yesterday.—Puck.

ELECTRICAL TERMS SIMPLIFIED.

Telegraph—A fast friend.

Thunder-Clap—A weather report.

—Queensland Telegraph Gazette.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

OFFICIAL ORGAN OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

SUBSCRIPTION PAYABLE IN ADVANCE. TERMS—DOMESTIC, ONE DOLLAR PER YEAR; FOREIGN, TWO DOLLARS PER YEAR. RATES FOR ADVERTISING ARE MODERATE.

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VOLUME IV. AUGUST, 1897. NUMBER 5

FOR TABLE OF CONTENTS SEE PAGE 108.

EDITORIAL.

AN IMPORTANT ANNOUNCEMENT.

The Pacific Coast Electric Transmission Association, at its Santa Cruz Convention, selected the "Journal of Electricity" as the Official organ and for the publication of all the papers, discussions and transactions of that most important body.

It was pointed out in a recent editorial that the Far West is the proving ground of electric transmissions and all will accede to the statement that the renown which the Pacific Coast has won in the electrical engineering world from its courageous pioneering of long distance transmissions, as is well merited as is the fame of the Golden State for the pluck and grit of those who pioneered it in the "days of '49." Portland pioneered electric transmissions for lighting on a large scale nearly ten years ago. Pomona pioneered 10,000 volt transmission in the winter of '92-3, then followed in rapid succession, Bodie and Walla Walla with single phase synchronous power transmission, Redlands with three-phase power transmission, Sacramento with its 3,000 horse-power transmission, Fresno with its longest distance transmission and Newcastle with its 15,000 volt transmission. Now the eyes of electrical engineers are upon Southern California, where a transmission of 3,000 horse-power eighty-two miles at 33,000 volts is under construction. Surely none will deny the Pacific Coast the honor of pioneering electrical transmission in America.

Thus has the Far West taken the lead and for this reason will other communities profit by its transmission experiences—experiences in which it is ripest. It is to be expected that most interesting problems should arise in the development of transmission enterprises; it is meet that their managers should seek interchange of opinion concerning these problems and that an association should be formed for mutual protection and the collection and dissemination of information relative to the generation, transmission and distribution of electrical energy. And, finally, it is natural that such association should choose as its mouthpiece the representative electrical periodical of the Pacific Coast, namely, "The Journal of Electricity."

Let the engineering world know then that in these columns alone may be found unabbreviated reprints of all papers and exhaustive reports of the proceedings of the Pacific Coast Electrical Transmission Association—the only body of its kind in existence—and wherein will be discussed with unreserved technical detail the experiences of the companies forming the association in all matters, whether in problems involving electrical, hydraulic or mechanical engineering.

THE JOURNAL BESTOWS A MEDAL.

The proverbial good fortune that popular report has ever attributed with directing the financial ventures of Mr. Charles R. Lloyd, seems to have deserted him in an interesting suit recently brought against him for above $14,000 on a promissory note given in payment for the water power at Kehl's mill in San Bernardino, Cal. It seems that when Mr. Lloyd established the San Bernardino Electric Light Company, he acquired this water power under representations that it amounted to about 190 horse power, but afterward he learned that the power available fell materially short of that amount, whereupon he refused payment on the note and suit was brought to recover.

There is nothing in any detail of this transaction to elicit wonderment, but the extraordinary feature is to follow: Relying on his past record of never having lost a suit, Mr. Lloyd was evidently indifferent to the necessity of taking technical precautions in his defence, as a result the case went to the jury with a charge from the court to the effect that the measurement of the horse power of a stream of water is a matter of individual opinion, rather than a matter of fact!

Now who shall be decorated with distinction in this justly conspicuous case? The ignorance of the court, which acted upon the testimony adduced, may

be overlooked, but the intellectual short-sightedness of Mr. Lloyd in this instance, accords him that honor and to him is awarded a leather trophy of great rarity which is attested to have cost something upward of fourteen thousand dollars net.

There are other brilliant individuals on this prolific occidental shore who are deserving of distinction for equally noteworthy achievements and to many of whom the Journal should award a similar leathern trophy. Mr. Lloyd is not the only nugget on the Klondyke.

WHERE ARE WE AT?

There are numerous questions in the category of business relations which inherently seem to be impossible of solution. To some the telephone industry appears to constitute a natural monopoly; others contend for the municipal ownership of quasi-public corporations and there are many who believe that gas and electricity, instead of being natural enemies which like cat and dog, fight between themselves at every turn and have common interest only in catching the fattened rat of public patronage, should advance in harmony along every line and together form the elements of one great lighting industry that shall stand ever ready to serve whatever variety of illumination the public may require. It is a pretty conceit, this idea of a single corporation that harbors no discord between the two great illuminating agencies that are so invariably at outs, but before committing one's self to its endorsement it is well for electrical industries to pause and put to itself the above query so apt in the vernacular.

Is there anything in the wedding of gas and electricity that is of disadvantage to the latter? Electricians generally will contend that there is, for the electric bride will in every case lose her name, then her identity and at last will be blended so effectually into the ways of her gaseous spouse that she will become the mere adjunct of a crochety consort who detests, yet endures her, because she is a favorite belle of the society in which he moves. He cannot get along without her for fear of being unconventional, so he takes her unto himself and makes the best of her, not for the good of her companionship, but purely as a matter of policy. The union is by no means a love match—rather is it a fruit of the crafty intrigue of long-headed business men who serve no master save their own financial betterment and who, like unfeeling parents of other countries, plan and carry out the wedding without consulting the interests of its principals.

Is the growth of the electrical industry advanced or retarded by its amalgamtion with gas interests? Is the universal knowledge that the sale of gas is relatively more profitable than the sale of electricity, conclusive evidence that if the gas intersets predominate the use of electricity will be discouraged whenever and wherever possible?

Does the motive which actuates gas interests to absorb electrical concerns lie solely in the idea of suppressing, in every way possible, a popular competing industry otherwise destined to be formidable? Has the long conservatism of the gas companies given them alone the wisdom to direct the affairs of electrical industry to the individual haven of its greatest good? Has it ever occurred that the consolidation of gas and electric companies resulted otherwise than in bettering the condition of the former as an industry and in worsting the condition of the latter as an industry?

In brief, can it be established as fact that the unification of gas and electricity does not invariably relegate the latter to the background and render it in every possible way impotent in all progressive and expansive development?

THAT BLUDGEONLESS BOGY.

Tradition, they say, hands down a fable of a visitor to a lunatic asylum who, after inspecting the various wards, entered the men's recreation grounds where several hundred inmates were amusing themselves in athletic exercises, or basking on the lawn, or otherwise finding enjoyment, each according to his inclination. The visitor was particularly impressed with a certain great stalwart lunatic whose muscles were as the gnarled oak, whose sharp eyes pierced javelin glances and whose presence was terrifying in its might. His physique was indeed a magnificent habitation for a demented brain, and the visitor in admiring the one, sorely pitted the other.

But the tiger-like keenness with which this lunatic watched every movement of the visitor was from the outset most disquieting to the latter. His every action is noted and aped; he walks and the lunatic walks; he quickens his pace and the lunatic does likewise; he stops and the lunatic stops too, always eyeing the visitor with the wild, fierce, yet cunning and hypnotic look so peculiar to madmen. The visitor is soon terrified at the thought that he may be in a lunatic's power, and determining to leave the grounds, he started toward the gate. The lunatic started too; he broke into a run, but the lunatic was at his heels; he dodged hither and thither, constantly increasing his speed, but the demented being shadowed his every movement until he fled with all the superhuman energy born of abject terror. Wildly on the chase continued until at times he fancied he could feel the hot breath of the mighty mad man upon him—more merciful, he thought, would the starving lions of the jungles of India be than this wild human monster. Oh, the acute mental tortures of the hapeles victim cannot be described! With failing strength he feels that the chase will soon be over, then, heaven only knows what horror will befall him. At last the end is come and, with the blood bounding through his veins, with nerves unstrung and with utter exhaustion and abject terror up-

on him, the poor hunted wretch can go no further. He reels in his terrified frenzy while the lunatic bounces to him and tapping him on the shoulder, cries out: "Tag, you're it!"

And so it will be with the Berliner bogy—that offspring of the Patent Office whose questioned legitimacy of birth has been settled, but whose intellectual soundness, so to speak, is so generally impugned. This bogy is of fearful mein, to the uninitiated. It advances, meances, receeds, then advances and menaces again, threatening the dismemberment of the hoped-for victim, and when at last it may perchance pounce upon the terror stricken, its threatened annihilation will be but a harmless stroke while its "Tag, you're it!" will tell that it is all but a game and one in which other fellow has his inning.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

A TRADE CATALOGUE BUREAU.

The mass of really valuable engineering information that annually appears in the form of trade catalogues is something inconceivably enormous, and for engineers to accumulate, systemize and preserve it is impossible. It is with pleasure therefore, that announcement is made of the recent organization of the American Catalogue Bureau of Cleveland, Ohio, which will, about October 1st, open free libraries and bureaus of business information in the fifteen largest cities of the United States where the general public may gain much valuable information concerning all lines of manufacturing. Such an enterprise if properly conducted, will form a veritable boon to all trades and professions.

It is with the view of assisting in the organization of this project that all readers of the "Journal of Electricity" are requested to mail one of their most recent catalogues to the American Catalogue Bureau at Cleveland, Ohio, without delay.

SAFETY IN LIGHTING MINES.

The fierce fire which recently raged in the Utica gold mine in Calaveras county proved a very expensive object lesson in demonstrating at least the financial wisdom of installing only the safest possible means of illumination in mines. The Utica mine, though a richly paying property, is yet lighted by the primitive method in which miners carry lamps on their hats, and the origin of the fire was due to the carelessness of a miner who, in trimming his lamp threw the lighted wick amidst a pile of timber. The mine is the largest quartz gold mine in the world worked by the chlorination process, having 200 stamps and fourteen roasting ovens and employing between 600 and 700 men, with a monthly expenditure of $70,000. It is estimated that the annual output equals $1,800,000.

The art of incandescent electric illumination has long since reached such perfection that in properly installed plants the occurrence of fire from its circuits is a virtual impossibility, and money spent by mine owners for properly installed incandescent lighting systems is an expenditure made in the nature of the proverbial "stitch in time."

THE WORLD'S GREATEST ELECTRIC PLANT.

The last number of the Journal announced the awarding of a contract to the Westinghouse Electric and Manufacturing Company for the building and installing of fifteen, 5,000 horse-power polyphase generators in the works of the St. Lawrence Power Company, to be located at Massena, N. Y., and a brief description of this, the world's greatest electrical generating plant, is of interest:

The company is to take water from the unnavigable channel of the St. Lawrence at Long Sault Island, and to carry it thence through a canal about three miles in length to Massena, which is located on Grass River. This is a small stream flowing parallel to the St. Lawrence and re-entering that river below its rapids, while at the rapids, the level of Grass River is 45 feet below that of the St. Lawrence. At Massena, the water from the proposed canal will have a head of about 47 feet and the canal is to have a capacity of 150,000 horse-power. The water, therefore, is to be taken from the St. Lawrence above the rapids and after actuating the wheels, will return to the St. Lawrence through the Green River acting as a tail race.

The generators and turbines are of the same size as those used at Niagara but differ therefrom in that they are of the horizontal shaft type, forming direct connected sets running at 180 revolutions per minute. Each of the generators will weigh 350,000 pounds, the weight of one piece in each being about 125,000 pounds. Each machine stands about 22 feet high above the foundation and occupies a floor space of 22 feet by 18 feet. The shaft carries a revolving field, consisting of 20 external projecting pole pieces and having an external diameter of 15 feet by about 3 feet in width. The field ring revolves at a speed of nearly two miles a minute and the centrifugal force is such that each pound at the circumference tends to fly outward with a force of nearly 100 pounds. Three-phase current is to be produced at a frequency of 30 cycles per second.

TECHNICAL TERMS DEFINED.

Water Rheostat:—A wooden box that cannot be made to hold water. Commonly termed, when tight, "just an ordinary tank."—J. F. Dearth.

Fraternal

THE TRANSMISSION CONVENTION AT SANTA CRUZ.

As heretofore published in these columns the Pacific Coast Electric Transmission Association was organized in San Francisco on June 7th last, having for its object as stated in its Constitution, "the mutual protection, collection and dissemination of information relative to the generation, transmission and distribution of electrical energy. The electric transmission companies constituting its membership at present are the Blue Lakes Electric Power Company, of San Francisco, The Big Creek Power Company of Santa Cruz, The Central California Power Company of Sacramento, The Nevada County Electric Power Company of Nevada City, The Portland General Electric Company of Portland, The Power Development Company of Bakersfield, The San Gabriel Electric Company of Los Angeles, The Sacramento, Electric, Railway and Gas Company of Sacramento, The San Joaquin Electric Company of Fresno, and the Southern California Power Company of Redlands.

The first business meeting of the Association was held in Santa Cruz, Cal., on August 17th and 18th, there being present Messrs. C. P. Gilbert of Sacramento, Robert McF. Doble of San Francisco, F. W. Swanton of Santa Cruz, A. C. Balch of Los Angeles, C. N. Beal of Bakersfield, E. W. Sutcliffe of Sacramento and J. S. Eastwood of Fresno. Those present by invitation, were Messrs. J. A. Lighthipe, R. S. Masson, F. M. Pickering and A. M. Hunt of San Francisco, W. G. Barrett of Los Angeles, C. W. Quilty and H. J. Edwards of San Jose, C. E. Lilly H. Willey of Santa Cruz, F. J. Cramm of Chicago.

The subject for the special consideration of the meeting was the general one of high potential insulalators, concerning which papers were read under the following themes:

"Insulators," by Dr. C. Van Norden, outlining experiences on the 15,000 volt transmission lines of the Central California Electric Company.

"Insulators for use in the Transmission of Electric Power," by T. A. W. Shock, being an account of interesting experiences with insulators on the Folsom-Sacramento transmission line.

"Line Construction," by J. S. Eastwood of the Fresno transmission, being an exhaustive discussion of the essential features of pole lines.

"Insulators for Use On Transmission of Power Lines Operated at High Voltage," by Henry D Sears. describing desirable qualifications and the process of manufacture of high tension insulators.

These papers which will be reproduced in full in the next number of "The Journal of Electricity," the exclusive organ of the Transmission Association, evoked discussion of the greatest interest and value to electrical engineers.

Early on the morning of the eighteenth, the entire party started in carriages for the eighteen-mile drive to Big Creek in the Santa Cruz mountains, where the generating plant of the Big Creek Power Company is located. Arriving there the reservoir, flume, pipe line and station of the company were inspected, and considerable interest was evidenced in the work and plans of the Company. Among the other interesting features examined was the new dam which is now being completed by the Company, which has a crest of 540 feet, is 32 feet high and will impound water on what is known as the West Branch of the Big Creek about 1300 feet above the sea level. This dam will hold water covering 20 acres and will deliver 500 horsepower for four months each year. Two other reservoirs of the same capacity are contemplated and after they have been built the Company will build transmission lines to San Jose.

After returning from the tour of inspection and partaking of a sumptuous collation at the power house, the members resolved themselves into executive session, during which the "Journal of Electricity" was accorded the official organship of the Association with the exclusive right to the publication of all papers and discussions before it.

The next meeting of the Association is to be held in Sacramento on October 20th, and to continue thereafter as long as necessary. The subjects to be considered at this meeting will be a continuation of the insulator question with an especial consideration of the problems attending protection against lightning. It is probable also that hydraulic matters will receive considerable discusson. During the Sacramento Convention, the Folsom power house of the Sacramento Electric, Railway and Gas Company will be inspected and a trip will be made over the 15,000 volt transmission system of the Central California Electric Company at Newcastle.

Electro-Economics

THE ACCURACIES OF THOMSON RECORDING WATTMETERS.—I.

By H. N. Sessions.

Owing to the rapid development and extensive use that has taken place within the past few years in the styles of electric meters, a discussion on the points yet to be improved will perhaps be of interest. Of course it cannot be denied that the old zinc-copper-chemical meter is the most accurate of all; but the great expense connected with taking statements from and maintaining this meter has forced lighting and power plants to abandon its use and to adopt the mechanical meter in its place. San Francisco may well be proud to be known as the first city to determine this difference and to use the mechanical meter exclusively on all customers using low potential current.

Among mechanical meters the Thomson recording watt meter has been generally adopted to ascertain the watt-hour consumption and output of various electrical apparatus. There are certain features connected with the construction and operation of this meter however, that may readily be discussed advantageously. The mechanical meter has so far satisfied both those selling and buying electricity for the reason that those who sell are confident of their meters, and on the other hand, those who buy electricity cheerfully accept as

accurate the measure of work of a science not understood by them and upon being charged with a drop or raise in the bills of 10 or 20 per cent, their only alternative is to credit the variation to an unconscious use of light or power. Nevertheless, years of practice have shown that this 10 per cent or 20 per cent variation may be wholly in the meter itself.

Before we investigate the causes that may make meters fast or slow after they are installed, let us first study and understand their general construction; then we will readily see that it is next to an impossibility for a meter to register with absolute accuracy and contend with the conditions to be met with on the outside.

The meter may be described as being a shunt motor, having very low resistance fields which are connected in series with the lights or power to be used. The armature circuit of very high resistance is connected straight across the service mains and provided the potential does not change, the armture strength remains constant. The speed of the meter depends upon the strength of the fields which in turn is in proportion to the number of lights or amount of power in series with them, or in other words, on the amperage traversing the field coils. The armature shaft revolves in a vertical position, its weight resting on a lower jewel. A worm on the shaft is meshed to a gear in connection with the series of gears which moves the indicating hands. The speed of the meter is reduced by an inductive brake consisting of a copper disk carried by the armature shaft and revolving between the poles of permanent magnets. These magnets may be shifted to or from the center of the disk, thus decreasing or increasing the leverage of drag and regulating the speed.

The power absorbed by the disk by induction adjusts itself to any load that the meter may be running on, because the amount of current induced in the disk is in exact proportion to its speed. The friction on the jewels, gearing and commutator of the meter is of sufficient amount to absorb a large percentage of the power necessary to propel the meter on low loads. Inasmuch as this percentage of power increases as the load decreases, the meter is often very slow on light loads and sometimes stops on the smallest loads. Steps have been taken to balance this friction by inserting within the field of a starting coil of very fine wire connected in series with the armature circuit; but, with the friction of the meter thus balanced, it very often registers when no current is being used, especially when vibration is met with.

After the meter has been carefully calibrated and balanced on light loads, it will generally be found fast on heavy loads, where the friction that gave so much trouble on light loads now enters as a very small factor. There will be a point, however, between minimum and maximum loads, where the meter will record correctly.

One point about the watt-meter, and perhaps not the least in the favor of the companies selling light and power, is the very small percentage fast that their meter would have to record on large loads to discount a large percentage slow and even a stoppage of the meter, on small loads. For example, a meter reading 5 per cent fast on 600 lamps burning for 1 hour would discount an error of 50 per cent slow on 10 lamps burning 6 hours.

After discussing the construction of the meter, we may now look into the changes that may occur from surrounding influences after it is installed. Any magnetic bodies such as motors, magnets or heavily loaded feeders, when placed at the sides of the meter, will influence it by helping to diminish or increase the strength of the fields within, making it run fast or slow, or even backwards, when no current is being used. The permanent steel magnets which retard the motion of the disk often lose their strength through aging, thus making the meter run fast and on the other hand as the meter is not dust proof, iron particles might collect on the magnets and slow it down.

A very important feature which causes a great deal of trouble is the high resistance coil of fine wire in series with the armature. In damp places, owing to the difference of potential between the turns and layers of this resistance, sections of it often become short circuited, causing an increase of current in the armature and again the meter is made to run fast. But if too great a section of the resistance should be cut out the amperage would rise beyond the carrying capacity of the wire and result in burning out the resistance. This of course would open the shunt circuit and cause the meter to stop.

It is impossible to balance the friction of meters where there is vibration, the reason being that the balancing force remains the same and with vibration the amount of friction is continually changing. Suppose the meter to be standing still and balanced on no load. A vibration wil tend to remove the weight of the armature shaft and disc from the lower jewel, thus lighting and overbalancing the friction and causing the meter to register without using current. The working parts of the meter give very little trouble if cleaned regularly.

In view of this discussion regarding the facts concerning electric meters, not only the makers and sellers of electricity should inspect their meters, but, in many cases, it would profit the consumers to have their meters independently experted.

THE PACIFIC COAST GAS ASSOCIATION.

The annual meeting of the Pacific Coast Gas Association was held in San Francisco in the middle of July, as usual, and during which the following papers were read and discussed:

"Spontaneous Ignition of Coal," by John L. Howard, San Francisco.

"Reminiscences," by Mr. F. H. Eichbaum, San Francisco.

"Value of Small Gas Bills," by Mr. W. W. Gillespie, San Francisco.

"From Coal Gas to Natural Gas," by Mr. John Kempf, Jr., Salt Lake City, Utah.

"Small Lighting Plants and Their Management," by Mr. Thos. D. Petch, Eureka, Cal.

"Practical Suggestions," by C. E. Burrows, Walla Walla, Wash.

"Uniformity of Accounts," by Mr. C. O. G. Miller, San Francisco.

"Municipal Control," by Mr. C. W. Quilty, San Jose, Cal.

"A Short History of a Long Life," by Mr. C. M. Converse, San Francisco.

"Recuperative Benches for Coke and Coal Firing," by Mr. D. R. Russell, St. Louis, Mo.

"Card Bookkeeping," by Mr. V. Stow, San Francisco.

"Gas as Fuel," by Mr. F. Foveaux, San Francisco.

"Wrinkle Department," edited by Mr. M. C. Osborn, San Diego, Cal.

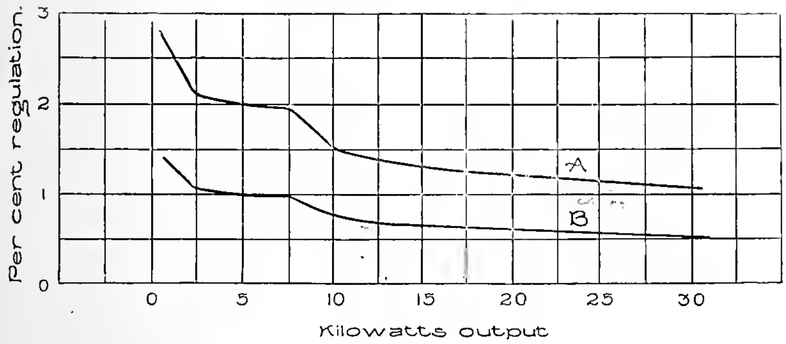
"Experience Department," edited by Mr. John Clement, Red Bluff, Cal.

Illumination

THE USE AND ABUSE OF TRANSFORMERS.—II.

(Continued from page 83)

REGULATION, a very important property in a good transformer is regulation—that is, its ability to hold its secondary voltage at or near a particular value, irrespective of load. On the regulation depends in a large measure the character of the service that may be rendered, for it determines the variation of voltage to which the lamps are subjected, and inasmuch as the light given by a lamp, and its commercial life, vary very rapidly with the voltage, the importance of fine regulation in improving the illuminating service, and in insuring durability of lamps is self evident. It has generally been considered difficult to secure



at the same time low core loss and the very best regulation, the relation between the two in transformer design being such that in improving the one the other may be impaired. In the Type H transformers, the magnetic leakage and the losses in the copper are both small, and these are the two factors which chiefly influence regulation. The regulation of these transformers is correspondingly good. That the copper losses must be small is attested by the high efficiency. The failure in regulation due to magnetic leakage, is greatly reduced by the use of a single magnetic circuit of such shape that the possible paths for the leakage of magnetism are unfavorable and long. Hence not only is the regulation good in ordinary service, but it continues to be good when the load possesses considerable inductance, as in the case of operating motors. The net result of the care that has been taken in the design and construction of the Type H transformers is not only to raise the efficiency to a point heretofore untouched in commercial transformers of corresponding sizes, but also to secure this efficiency, and the remarkable low core loss already referred to, with regulation correspondingly excellent. The table following emphasizes this point in a very striking manner.

This table is drawn from a series of very careful tests on commercial transformers made under the direction of Prof. D. C. Jackson, of Madison, Wis., and recently published. The tests were made on transformers of about the same size (averaging 1,500 watts capacity), from nine different makers. One of the former types of General Electric transformer is shown in the list. The others are by other makers. The following is the table, to which is added the regular figure for the Type H transformer.

NUMBER.	REGULATION PER CENT.
1	3
2	2.5
3	3.5
4	4
5	2.5
6	3
7	5
8	5
9	2.5
H	2.62

The figure for the Type H transformer is taken from the standard 1,500 watt size. It is worth noting that in the table indicated, Numbers 7, 8 and 9 were of greater capacity than 1,500 watts, the last mentioned being a 2,500 watt transformer.

Further reference will be made to this admirable series of transformer tests, but the data just given shows that in obtaining the all important properties of low core loss and great general efficiency, there has been sacrificed in the Type H transformer nothing of those excellent regulating properties which are essential to fine commercial service.

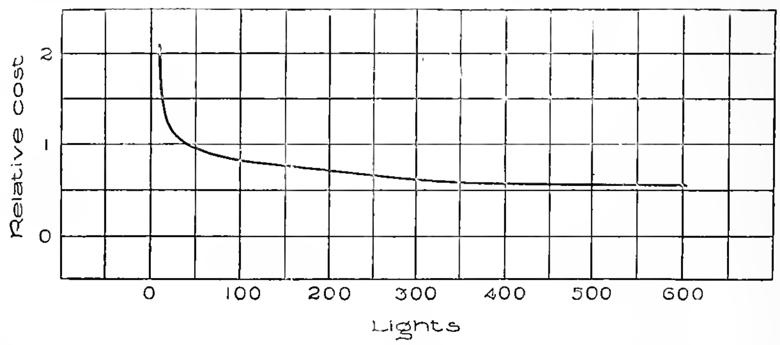
In the accompanying curve, A shows the regulation of "H" transformers in per cent of the voltage. The drop taken is from no load up to full load. Bearing in mind the fact that these transformers should be so installed as to give normal voltage under the ordinary conditions of load and not at full load, it will be seen that any one of these transformers, even the smallest size, is capable of holding the pressure on the lamps steady within 1.5 per cent under all variations of load and under all working conditions much closer than this. Curve B shows the maximum variations of voltage which will be obtained with proper care in installation for these various sizes of transformers. That the regulation may be so close, without any compensating sacrifice, speaks volumes for the care with which these transformers were designed and the skill with which the construction has been carried out.

Part ii

PROPER AND IMPROPER METHODS OF DISTRIBUTION.

The alternating current transformer should be regarded, so far as distribution is concerned, as a generator which indeed has an enormously high efficiency and requires no attention, but which is subject to the same general laws as regards distribution as any other source of electricity. A transformer plant is on a small scale a power transmission plant, the generating station being the primary source of energy and the transformers the secondary source of energy.

In the early days of transformer work it was the custom to install one of these secondary generators for each customer to be served, so that the transmission plant would be regarded as made up of a main generating station,



with secondary generators equal in number to the number of patrons. The distributing system connected to each secondary generator was then very short, simply consisting of house wiring. The result was that the transformers were on the average of very small size, corresponding to perhaps twenty-five lights capacity.

Now it is a well known fact that in any class of electrical machinery the cost per kilowatt decreases as the output increases, so that for example, a 100 kilowatt generator costs less that two 50 kilowatt generators, and these in turn less than four 25 kilowatt generators. The same holds true of transformers. One 10,000 watt transformer costs less than two 5,000 watt or four 2,500 watt transformers. Consequently it is for the interest of any one installing transformers, to use, in so far as it is possible, trans-

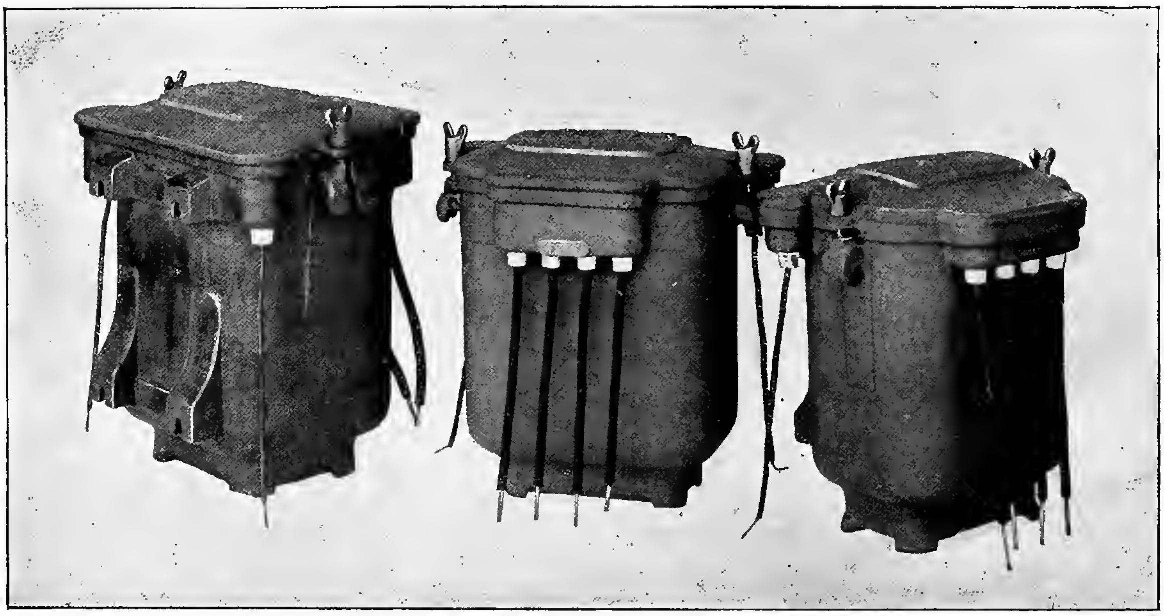
formers of such size that their cost shall be reduced as far as practicable. Of course if one transformer is made to serve several customers, the average distance over which lights have to be distributed is greater than if one transformer were installed for each customer; that is, in the secondary distribution more copper per light has to be installed than if the secondaries were shorter. Consequently if one decreases the cost of the transformers, by using larger sizes and fewer of them, the cost of the distributing system for the same service is somewhat increased.

Evidently then, a point will be reached where it will not pay to further increase the size of the transformers used, owing to increase in the cost of the copper. At the same time on this consideration alone it pays frequently to use transformers large enough to serve several customers, especially if these customers are conveniently situated. If, for example, a 100 light transformer costs $90 and five 20 light transformers cost $140, it would evidently pay to put in $50 worth of copper in the secondaries for the sake of using the larger transformer—the loss in the secondaries being retained at the same amount. This extra $50 is better spent for copper than for transformers, because the depreciation is less.

The preceeding curve shows the variation in cost of transformers per light, with increase in size, based on the market price of several well known makers. By applying this data to any concrete case it is easy to figure the amount of copper it would pay to put into the secondaries to avoid the use of small transformers; but this gain, which is purely a commercial one, and quite obvious, is small compared to the gain which may be made in other ways by the same process of increasing the average size of transformers used to supply any given district. For instance, in employing Type H transformers, the efficiency of a 100 light transformer at full load is 97 per cent; the efficiency of approximately a 20 light transformer is about 95.5 per cent, giving an advantage of 1.5 per cent in efficiency for the large transformer as against the smaller one. At one-quarter load the difference is still greater, the efficiency being 95.1 per cent for the 100 light transformer and not over 92 per cent for the smaller one. So in addition to the gain in first cost, there is a positive gain in efficiency, which means that each lamp supplied to a customer through large transformers, costs something like 2 per cent less than if they were supplied through small transformers. This means a small but certain source of profit, and what is thus true of the Type H transformer is true with immensely greater force of most of the other transformers in use, of which the efficiencies are generally lower than that of the Type H transformers at full load, and proportionately still lower at partial loads and in smaller sizes.

This is a second good reason for employing a moderate number of secondary generators instead of a large number, but this is not all. Suppose one undertakes to supply 100 houses with lights. Each of them, we will say, is wired for 40 lights, making a total of 4,000 installed. If each house has its own individual transformer, that transformer must be large enough to supply all the lights in the house, for there will be times when all the lights will probably be in service. To economize transformer capacity as far as possible, it is the custom under these circumstances to employ a transformer, which at normal load will carry a somewhat smaller number of lights than those installed, trusting in the event of an emergency that it will carry successfully somewhat over its rated capacity, as most transformers will.

(TO BE CONTINUED.)



Type H Transformers.—1500—1000—600 Watts.

INCORPORATION

San Francisco.—The Central Light and Power Co. Capital stock $1,000,000, in 100,000 shares, $50,000 of which has been subscribed. Directors: Frank Pauson, who subscribed $15,000; C. L. Ackerman, $15,000; Joseph Naphtaly, $10,000; A. E. Brook-Ridley, $2500; Joseph M. Loewe, $3000; Samson Gerst, $2500; J. W. Pauson, $2500.

This company has bought the Emporium plant, situated in the Parrott Building, in addition to lighting, which it will furnish, extend its outside lighting business by laying underground mains throughout the principal business section of the city. Mr. Brooke-Ridley is electrical engineer for the company and Mr. Napthaly is superintendent.

AN ELECTRIC TRICK FREE.

The Pacific Electric Company, of La Crosse, Wis., has secured the selling control of a clever device called the "Electrical Trick," by means of which a piece of money can be made to disappear in a mysterious manner so that even a very clever person would fail to detect how the illusion was accomplished.

The company uses this to advertise its Shade Lamps and Dental and Surgical Lamps and will be pleased to send it to anyone who will write for same, inclosing 4 cents in stamps to cover cost of mailing.

Personal

Mr. F. J. Cram of the Electrical Appliance Company of Chicago is on the coast in the interests of his house.

Mr. Sidney Sprout has been selected for the supervising electrical engineership of the Rawhide Electric Power Company.

Mr. B. C. Van Emon has been promoted to the managership of the Electrical Engineering Company of San Francisco, vice Mr. C. B. Sessions, resigned.

Mr. J. H. Thatcher, of Portland, Ore., secretary and superintendent of the Oregon Telephone and Telegraph Company, was a recent visitor to San Francisco.

Mr. J. M. Halliday, late superintendent of the Folsom power house of the Sacramento Electric, Gas and Railway Company, is now on the road for Yates & Co., oil dealers.

Mr. Jno. E. McGillivray, late of the equipment department of the Pacific Telephone and Telegraph Company, has become associated with the Brooks-Follis Electric Corporation in the capacity of telephone expert.

Mr. H. M. Kebby, prominent in California in the early days of cable railway building, but who has for several years past been located in various Eastern cities, has returned to San Francisco and has established an office at 59 First street as consulting engineer for street railway, power and electric plants.

Mr. M. A. DeLew, a well known electrician of Sacramento, and Miss Alice May Jordan, the accomplished daughter of Mr. and Mrs. L. C. Jordan, were the recipients of the heartiest congratulations of their many friends on the occasion of their marriage on August fourth, and to these congratulations the Journal of Electricity extends its kindest benediction.

Mr. E. J. Hathorne, auditor of the Fort Wayne Electric Corporation, is in San Francisco on business connected with the San Francisco agency. Mr. Hathorne was receiver of the old Fort Wayne Electric Company and is now secretary of the Fort Wayne Lamp Company, and it is probable that a result of his visit will be evidenced in the infusing of new energy into the San Francisco office of the Fort Wayne Electric Corporation. Mr. Hathorne resides in Boston and Mrs. Hathorne has accompanied him on his present trip. They are stopping at the Palace Hotel.

Educational

HEALD'S BUSINESS COLLEGE GRADUATES.

Following is a list of graduates of Department of Electrical Engineering of Heald's Business College, San Francisco, for the term just closed: H. A. Cave, Eureka, Cal.; F. W. Gale, City; H. D. Thaxter, Carson, Nev.; B. T. Viall, City; R. M. Nevins, Selma, Cal.: Geo. Heath, City; W. E. Tuft, Alameda, Cal.; W. O. Jennings, Red Bluff, Cal.; A. W. Stetson, City; Geo. Wagner, San Leandro, Cal.; J. Calvert, Mound House, Nev.; H. Schwartz, Alameda, Cal.; M. Konigsberg, City; A. Raabe, City; L. C. Cutts, Santa Rosa, Cal.; W. A. Genesy, Carson, Nev.; C. C. Hansen, San Rafael, Cal.; H. G. Black, San Leandro, Cal.; A. L. Sobey, Sausalito, Cal; H. Dorgeloh, City; J. Christenson, Salinas, Cal.; Dr. H. B. Pinney, Oakland, Cal.; J. Fortune, City; Carl Symonds, Mare Island, Cal.; Frank Pedlar, Oakland, Cal.; Geo. R. Knox, San Leandro, Cal.

The motion for injunction in the suit of Cahall vs. Babcock & Wilcox for infringements of patents has been decided in favor of The Babcock & Wilcox Company in the U. S. Court, Western District of Pennsylvania.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

FREE TO STEAM USERS AND ENGINEERS.

Engineers of whatever profession, the world over, recognize the hand book "Steam" as issued by the Babcock & Wilcox Company to be at once the finest, most accurate and comprehensive volume that has ever appeared concerning the generation and use of steam and the manufacture and development of steam boilers. A new edition of this celebrated work has just been issued and will be mailed free to any address on application to the Babcock & Wilcox Company, 32 First street, San Francisco.

Those who are interested in steam plants, will find a great deal to instruct them in the elaborate display which Charles C. Moore & Co. have made in the machinery section of the Mechanics Institute Fair, now being held in San Francisco. There can be seen a working model and sample parts of the latest type of the Babcock & Wilcox boilers, together with many examples of the high grade machinery that they have widely and satisfactorily installed in

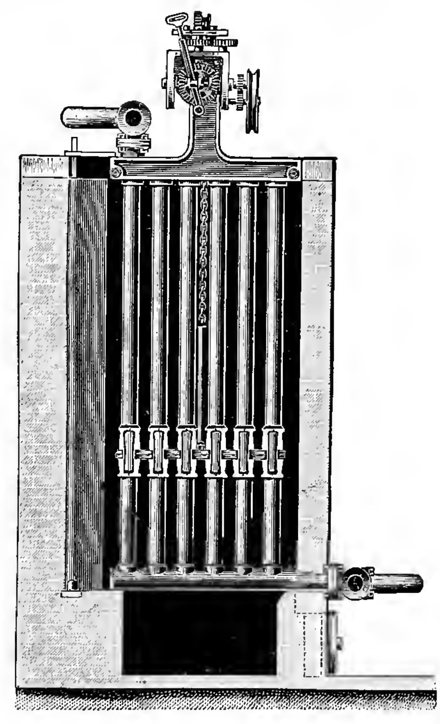


FIG. 1. CROSS SECTION THROUGH ECONOMIZER CHAMBER.

every part of the Pacific Coast and Hawaiian Islands. A visit to this exhibit can not but be most interesting and instructive, for there will be seen Babcock & Wilcox boilers, Green's fuel economizer, New York Safety, Hamilton-Corliss and McIntosh & Seymour engines, Stratton separators, Goubert heaters, Snow steam pumps, Quimby pumps, Hyatt roller bearings, Bundy traps, Edmiston filters, Wheeler condensears and Hopper purifiers.

That the reader will find something to his advantage in visiting this exhibit, is unquestioned, for novel devices of the greatest utility are there shown and their workings fully explained. Among these innovations special reference may be made to Green's fuel economizer for steam boilers. Users of steam power are fully aware that in all cases, whatever the construction of boiler, a large proportion of heat generated escapes by way of the chimney and that the highest possible degree of economy can not be attained so long as heat, which is expensively generated, is thus al-

lowed to go to waste. Green's economizer is recommended as being specially adapted for utilizing this waste of surplus heat from steam boilers,and by placing it in the main flue leading from the boilers to the chimney stack, it effects, in many cases, a saving of over 15 per cent of fuel by heating the feed water to a temperature very much above the atmospheric boiling point before entering the boilers. This apparatus is already applied to over 150,000 boilers which alone attests its value, but in order that an accurate idea of the saving it effects may be conveyed, the citing of an only two specific instances, may not be amiss. A report of a series of tests lasting seven days and made by the chief engineer of the South Chicago Railroad Company, which burns oil, shows that Green's economizer effected a saving of 15.76 per cent of fuel, which amounted to 251 gallons daily. At Cheney Bros.' silk works at South Manchester, Conn., feed water enters the boiler at a temperature as high as 295 degrees, the value of which will not be under estimated by an one conversant with steam engine practices.

Among the recent orders which Charles C. Moore & Co. have secured appears the contract for the heating plant for the Roman Catholic Theological Seminary at Menlo Park, consisting of two Babcock & Wilcox boilers and special heating apparatus built by the Goubert Manufacturing Company. They have also added the Belmont school to the list of educational institutions using Babcock & Wilcox boilers; these boilers being in use at both Stanford University and the University of California. Additional sales of Babcock & Wilcox boilers have also been made recently to different wine growers in Sonoma Valley and to the California Wine Growres' Association.

GROWING AND PROSPERING.

The Brooks-Follis Electric Company has been incorporated as the Brooks-Follis Electric Corporation, and on September 1 the new corporation will enlarge its premises by also occupying the store next door at 525 Mission street, where C. B. Kaufman & Company are at present located.

The large quarters will give the Brooks-Follis Electric Company much needed room, as the present store is badly cramped with the heavy stock carried. No further evidence is required to demonsrate the great popularity of this concern than a simple reference to its modest origin two years or so ago, its phenominal growth in a field which was, it was said, already overcrowded, and its present position as one of the leading electric supply houses of the Pacific Coast. Its unprecedented success may be attributed to prompt shipments, moderate prices, personal popularity and liberal use of printers' ink.

ELECTRIC POWER DISTRIBUTION.

It has ceased to be a question as to whether electric lights shall be installed in office buildings, apartment houses, hotels, etc., and whether power shall be distributed electrically about new mills, factories and work shops. To-day the questions of first importance are what apparatus shall be used and what system of distribution employed.

In selecting a dynamo for electric lighting the matter of toughness and durability should be given much greater consideration than the matter of the very lowest first cost. Especially where two or more dynamos are to be employed, the matter of strength and ability to carry temporary overloads cannot be measured against a trifle of first cost, which is also true of a dynamo having a comparatively high efficiency under partial loads.

With the approach of darkness the load on an electric light plant increases with more or less rapidity, depending on the character of load. Where two or more dynamos are employed, each dynamo should be able to carry for a reasonable period an overload of 25 per cent, which condition should be reached on the first dynamo before the second is thrown in. This is especially true of direct-connected dynamo and engine sets, and is conducive to the best efficiency of the steam plants.

The system of distribution of electricity for lighting are so generally understood and so thoroughly developed that construction firms of recognized reputation can be relied upon to install plants and wire buildings after well-designed plans and in a thoroughly satisfactory manner. Too much importance, however, cannot be

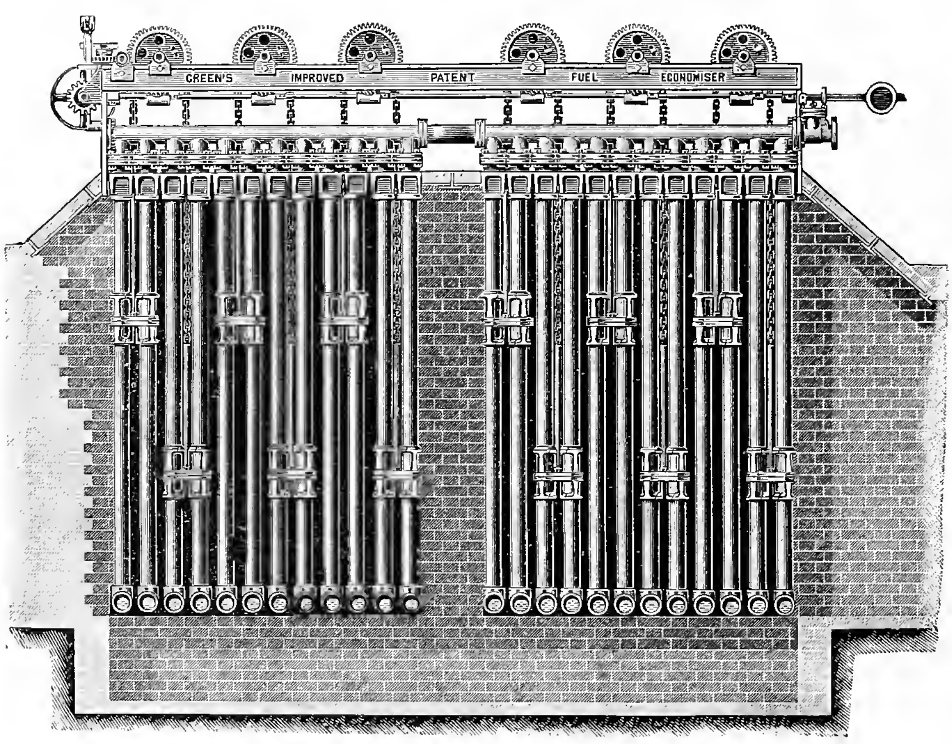


FIG. 2. LONGITUDINAL SECTION THROUGH ECONOMIZER CHAMBER.

given the substantial and thoroughly first-class character of the entire installation.

In considering the type of dynamo, the system of distribution, and the applications of types, capacities, speeds and methods of control of motors to be employed in the distribution of power from a central station plant about a city or town, or from a central plant in a mill or factory to the several buildings or departments and thereafter to the different machines, tools, or processes, becomes a much more complex subject for consideration, each case requiring, as a rule, individual analysis and treatment. Suffice it to say that the Crocker-Wheeler Electric Company have furnished some of the largest and most comprehensive plants of this character and have accumulated a fund of information and data which they are always glad to place at the service of their customers.

It would be impossible to here discuss adequately the best methods to employ in the distribution of power electrically, as the conditions are so divirsified that no general rules can be laid down or advice given. The Crocker-Wheeler Electric Company should be pleased, however, to have prospective users of electric lights or power to consult with them or with any of their representative selling agents, tthat there may be placed at their disposal the results of long, varied and successful experience in this line.

While methods of application and use in individual cases may not be discussed, several of the features which make the Crocker-Wheeler apparatus superior to all others, may be made clear.

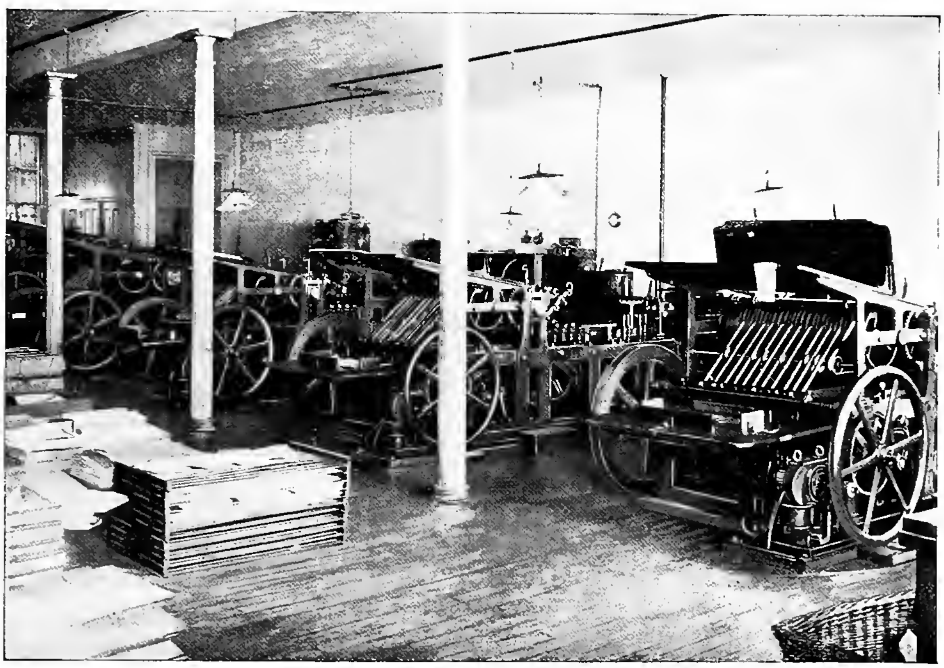
The Crocker-Wheeler dynamos and motors constitute machinery that is of the highest practical efficiency at full load and is capable of carrying its rated load continuously and considerable overloads for short periods comfortably. The mechanical and electrical design of the apparatus is such that it is exceptionally efficient through the entire range of load. As the average load on a motor is seldom more than one-half of its capacity, the matter of high efficiency at partial loads can not be too highly considered.

A Crocker-Wheeler motor was recently installed in place of one of another make, the parties using the motor having added in the meantime about 15 per cent more machinery. This motor was operated from a central station circuit through a meter, and since starting the new motor the meter bills have been greatly reduced, even with the added machinery..

Crocker-Wheeler apparatus costs little if any more than apparatus not so good and will soon save, in operating expenses and repairs, any difference in first cost. It is well and carefully manufactured and tough and will outlast 90 per cent of the apparatus on the market. In general this standard apparatus may be classed as of the bi-polar type for size 10 and under and of the multi-polar type for size 15 and over, special types being manufactured to suit special applications or purposes as occasion demands.

The pole pieces and fields of all apparatus of size 5 and over are made of soft cast-steel, and below size 5 of drop-forged soft iron. The matter of starting boxes, controllers and rheostats, as well as complete systems of motor control, have been given earnest attention, to the end that we are able to offer absolutely the best in these respective lines.

The illustrations presented herewith illustrate special applications of Crocker-Wheeler motors and when it is thought how few of the extensive manufacturing industries of the Pacific Coast have thus far made any effort toward eliminating the enormous losses of power due to belting and long lines of shafting, it is surprising that more such special applications are not to be seen. The illustrations are reproduced from photographs showing the use of Crocker-Wheeler motors in a rolling mill and in a press room, and, incidentally, it is not possible to find more trying duty for an electric motor to perform than these equipments which are new satisfactorily operating.



THE DIRECT DRIVING OF PRINTING PRESSES.

Detail dimensions, prints, capacities, speeds, weights and the lowest possible net prices will be furnished on application to the Abner Doble Co., San Francisco, who are the representative selling agents of the Crocker-Wheeler Electric Co., for the Pacific Coast.

A BABY ARC LAMP.

Among the novelties recently brought out is something new in the way of an enclosed carbon lamp giving 500 candle power and consuming $1\frac{3}{4}$ amperes at 100 volts. The lamp is made in two styles, for indoor service and water proof for outdoor use. The indoor type is handsomely finished in lacquered brass and has a length of about 20 inches over all. The carbons have a life of 150 hours and the lamps are made for either direct or alternating current service. Enough carbons are furnished with each lamp to last 1000 hours. These lamps are manufactured by the Brooks-Follis Electric Corporation, which will be pleased to correspond with any one desirous of further information or prices.

The Bay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

New uses for electricity are constantly being discovered. A fish dealer runs a wire up through his counter and shoves it into a huge block of fish, and then labels it "Electric Fish." Any one curious enough to touch the fish with his fingers receives a very perceptible shock, which convinces him that the fish is correctly labled. Yesterday a local dealer in pickles, who has a dozen varieties in pans set on top of the different casks, had a wire run along, with a little branch of copper wire running into each pan. This charged the pan so that any one putting a finger in the pan to sample one received a smart shock. Just whether this was intended to keep people from sampling the pickles or as a joke on those who intended to do so, is not known; but after putting a finger near one pan no one attempted to touch another. If one took up the pan or put his hand on the pickles he received no noticeable shock, but the sensitive end of a finger put near a pickle received a rather unpleasant jar.—Portland Oregonian.

The assured and all but completed purchase of street railways constituting at least three-fourths of the facilities of the kind now possessed by Los Angeles, by a foreign syndicate with an outlay of capital in excess of $4,000,000, affords the best testimony to the solidity of this city and the confidence existing abroad in its future we have had in a long time. Such an investment would be particularly noticeable in, and be received with the warmest kind of self congratulation by any of the largest cities of the union. The magnitude of the amount establishes the high degree of the faith of the investors, and the fact that the latter are entire strangers to this city and are not swayed by any feeling of local pride or influenced by a desire to bolster up investments already made here, but that as a cold, independent business proposition, they selected out of the numberless enterprises competing for the favor of capital, many of which are offered by cities of greater influence and supposedly wider fame than Los Angeles, one in this city, cannot fail to yield abundant satisfaction to all interested in the progress of our community. The incident clearly shows that Los Angeles has been listed in the mind of the capitalistic world with the cities that are to win.—Los Angeles Herald.

Saturday afternoon the clouds hung heavy in the skies that seemed to reach but a short distance in any direction on the compass from Marysville. They lowered at about 4 o'clock, and the roar of thunder was terrific. So terrible in many instances as to alarm the native Californians. Then came the flashes of lightning. It was of the forked or chain variety, and its playful proximity was not desirable. Such thunder and lightning passed beyond the ken of the "oldest inhabitant," and the returns from points beyond the city are anxiously awaited. In this city the lightning did some damage to the telephone and electrical wires, and in one instance spent the awlfulness of its force on a tree and shed. This was at the residence of William Leech on E and Thirteenth streets. His wife and aughter were sitting on the back porch at a few minutes before 6 o'clock. They were not frightened at the frolicsome lightning until all at once there was a sound and a flash that was so near and so awful as to almost fasten them to the floor. Investigation then showed the lightning had torn a heavy door from a carriage house and splintered the 6x6 timbers on which it hinged. Parts of the door were scattered all over the yard. Nearer the house and not twenty feet from where they were sitting the bark was peeled off a limb of a big walnut tree, and a dozen or more small birds were killed and dropped to the ground. This performance is said to be the first of its kind on record in Marysville—Marysville (Cal.) Appeal.

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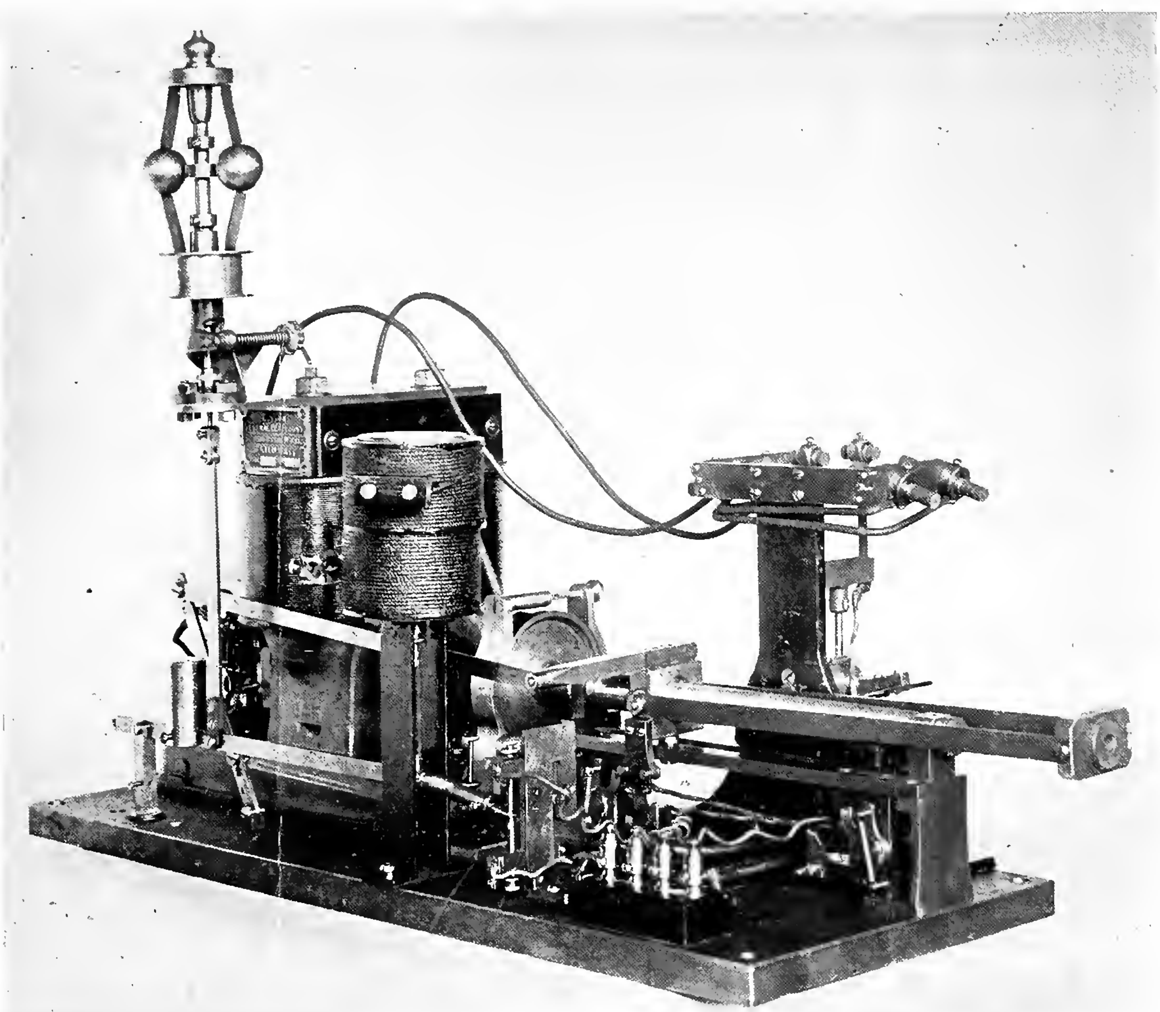
Water Wheel Government.

The regulation of water power employed in the operation of dynamo-electric machinery has ever been a cause of grave concern and it is safe to say that at the present time a great majority of stations so driven are experiencing more or less difficulty in the governing of their water wheels. So universal has been the complaint from this source, and so general have been the investigations into the intricacies of the problems presented that the descriptions of new and meritorious devices presenting epoch-marking innovations concerning the government of water power, cannot but be gratefully received.



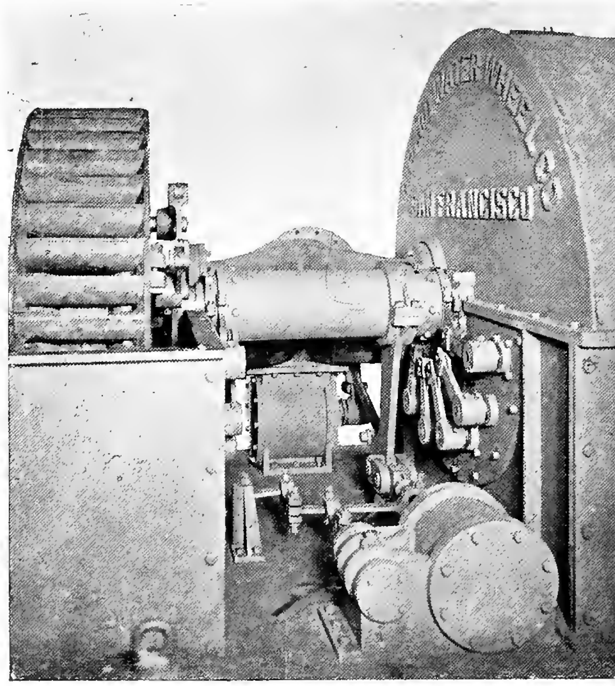
THE LIGHTHIPE GOVERNOR—FRONT VIEW.

The true function of a water wheel governor was very happily described in Mr. Mark A. Replogle's recent contributions to these columns* on "The Government of Water Power" in which he said, "a good governor can only play the part of an honest judge; evidences of strife in the form of changes in load are placed before it; facts of design and construction are placed at its disposal; the unerring laws of physics are brought to bear on each new case, and honest judgment is meted out in the form of speed or govern-

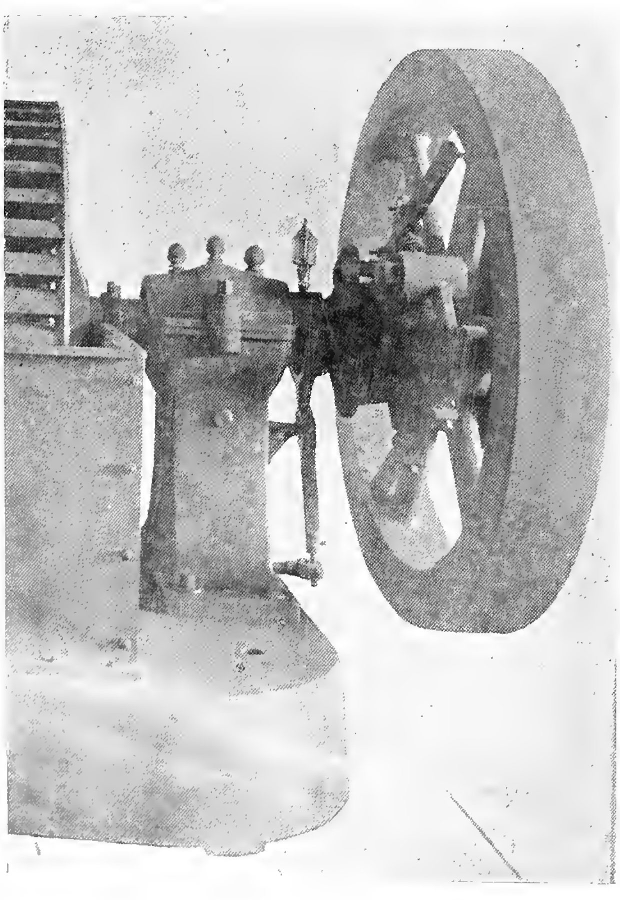
* Vol. iv, pp. 49 and 70.

ment of the plant, and no jury or Supreme Court can set aside the verdict."

Hitherto and in general, the prevailing principle upon which water wheel regulators have been constructed has been virtually that of the steam engine governor, in which the slowing down or acceleration of speed opens or closes the thrôttle sufficiently to restore the engine to its normal rate of revolution. Obviously, therefore, a marked variation in speed must occur before the governor can, so to speak, take its cue and act its part. This, of course, consumes an appreciable interval of time which is further enhanced by the time taken by the governor in acting, the latter interval being quite material owing to the means adopted for overcoming see-sawing. Concisely stated, in the form of governors now generally used, the evil of variation in the speed of the prime mover must have actually occurred before the governor can commence to correct it. To perceive a coming variation before its advent is a desideratum, and this idea forms the basis of two water wheel regulators that have recently been developed in San Francisco. One of these governors—the Girard—is entirely mechanical in operation and is actuated by any variation in the armature speed with practical independence from the speed of the water wheel, even though to all intents and purposes directly connected to it. The other governor—The Lighthipe electric—is actuated by any variation in the ampere output of the generator, and it is believed to be more ready and quick in action than any governor heretofore in use. That these two governors, particularly the latter, present distinctive features which most nearly satisfy the requisites of an ideal governor, will be evident in the description of them. That the workings of these governors may be clearly understood, it is advisable to describe first the mechanical regulator, whence may be followed more readily the principles and operation of the Lighthipe governor.



Ram, Nozzle and Pass-By Equipment of the Girard Governor.



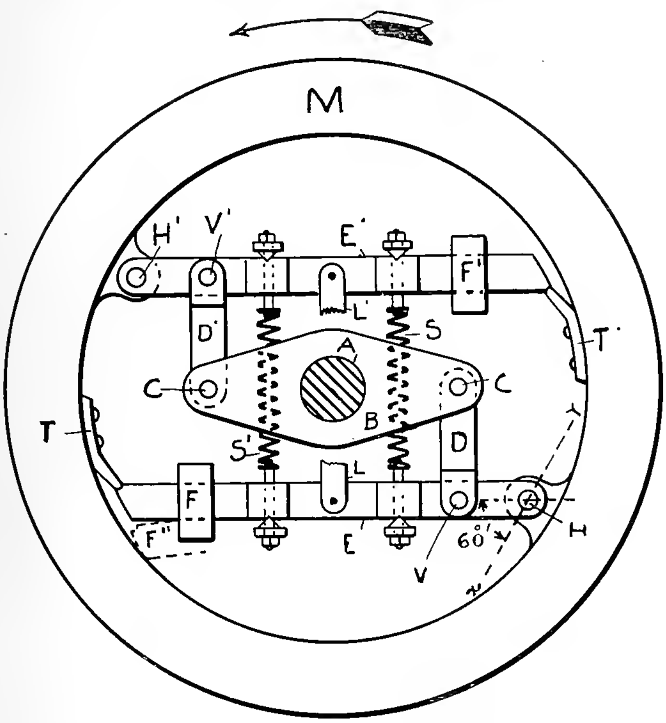
The Girard Fly-wheel Governor.

The Girard governor, briefly described on page 89 of this volume, presents to the person acquainted with steam engine practice the appearance of the ordinary form of shaft governor, but that it is not such will be evident upon an examination of the accompanying illustrations. Its mode of action is best described by reference to the outline drawing which is here reproduced. The main water wheel shaft extends for a short distance into the hub of the fly wheel and is a free fit therein, that is, were it not for the governor fittings the fly wheel would be mounted upon the shaft as an idle pulley. This fly wheel is attached by an insulated flanged coupling direct to the generator shaft, and being bolted rigidly thereto consequently always revolves therewith. Clearly then the function of the fly wheel is to increase the capacity of the armature for storing rotative energy, and as will be shown, the fly wheel and armature combination is not rigidly coupled to the water wheel shaft and moreover any increased tortion in the shaft owing to an increased load, or vice versa, is mechanically communicated to the nozzles before the speed of the water wheel can have been materially affected.

On the water wheel shaft is keyed a double crank which has at the extremities of its two arms, crank pins and links affording connection between the term-

inals of the double crank and the swing levers as will be seen in the illustration on page 110, but which is more clearly shown in the outline drawing on page 111. The two swing levers are attached to the fly wheel at one of the ends of each, while their opposite ends carry adjustable weights and the levers are drawn together by means of tension springs located at equal distance on each side of the shaft. Rigid stops are provided on the inner rim of the fly wheel to prevent the levers from drawing too close to the shaft, and when revolved the outward throw of the levers due to centrifugal force is limited by the outer end of the levers coming into contact with the inner surface of the wheel rim.

The oil cup appearing in the illustration on page 110 is mounted on a slip collar on the shaft and the slip collar is actuated forward or backward by means of



DETAILS OF THE GIRARD GOVERNOR.

links and bell crank levers connected to the governor levers through the links L. and L.; in the diagramatic illustration. The motion of this slip collar is carried under the water wheel by means of the lever shown, to the balance valve of the hydraulic cylinder appearing in the illustration on page 110, which is thus controlled so as to open or close the nozzles and bypass valve of the main wheels, as may be required.

The Girard water wheel installation here described is that of the Power Development Company of Bakerfield, Cal., which, as stated heretofore,* consists of two double sets of 44-inch Girard wheels, each wheel of each such double set being supplied by seven rectangular jets so controlled by the governor that as the orifices are closed by the rocker valve cut-off mechanisms, the orifice of the by-pass valve is correspondingly opened, and vice versa. The arrangement therefore admits of no saving in water, but precludes any possibility of water ram in the pipe line.

The Girard water wheel plant referred to was sold under the guarantee, that upon a sudden variation of load amounting to 25 per cent in either direction, th variation in speed resulting therefrom should not exceed 5 per cent from the normal speed. During the past month the wheels were subjected to tests for regulation by Messrs. Cobb & Hessmeyer, acting as hydraulic and mechanical engineers for the Power Development Company, and the results obtained are subjoined. Standard tachometers were used and the variations given are maximum, above or below from the normal speed of 257 revolutions per minute. These variations were momentary in either direction and in no instance did the interval of time required for the normal speed to be restored, exceed two seconds. The results were as follows:

First test: On an increase of load from 5-16 load to 7-16 load; maximum decrease 7 r. p. m., maximum increase 3 r. p. m.

Second test: On increasing the load from 7-16 load to 1-2 load; maximum decrease 9 r. p. m., maximum increase 3 r. p. m.

Third test: On an increase of from 1-2 load to 3-4 load; maximum decrease 12 r. p. m., maximum increase 5 r. p. m.

Fourth test: On an increase of from 1-2 load to 3-4 load (a repetition of test 3;) maximum decrease 12 r. p. m., maximum increase 5 r. p. m.

Fifth test: On a decrease from 3-4 load to 1-2 load; maximum increase. 13 r. p. m., maximum decrease 10 r. p. m.

Sixth test: On a decrease from 3-4 load to 3-8 load; maximum increase 15 r. p. m., maximum decrease 12 r. p. m.

Seventh test: On a decrease of from 3-8 load to 0 load; maximum increase 13 r. p. m.

It should be clearly understood that as stated the speed variations recorded show the maximum variations indicated by the tachometer and that, in the fifth test, for instance, when in carrying a three-quarter load, the load was suddenly decreased to a 1-2 load, the speed momentarily increased to 270 revolutions, (i. e., 13 above normal,) and then dropped to 247 revolutions, or 10 below normal before returning to the normal speed of 257 r. p. m., all of which was accomplished during an interval of two seconds. In this test the sudden variation in load amounted to 33 1-3 per cent, yet the momentary variation in speed was but 5 6-100 per cent, which more than satisfies the guarantee.

Here should be noted the feature wherein the Girard principle of governing is a material step in advance of all others of the ordinary type, namely, in that the power of the water wheel is transmitted to the generator shaft through a system of springs and levers that change in relative positions according to

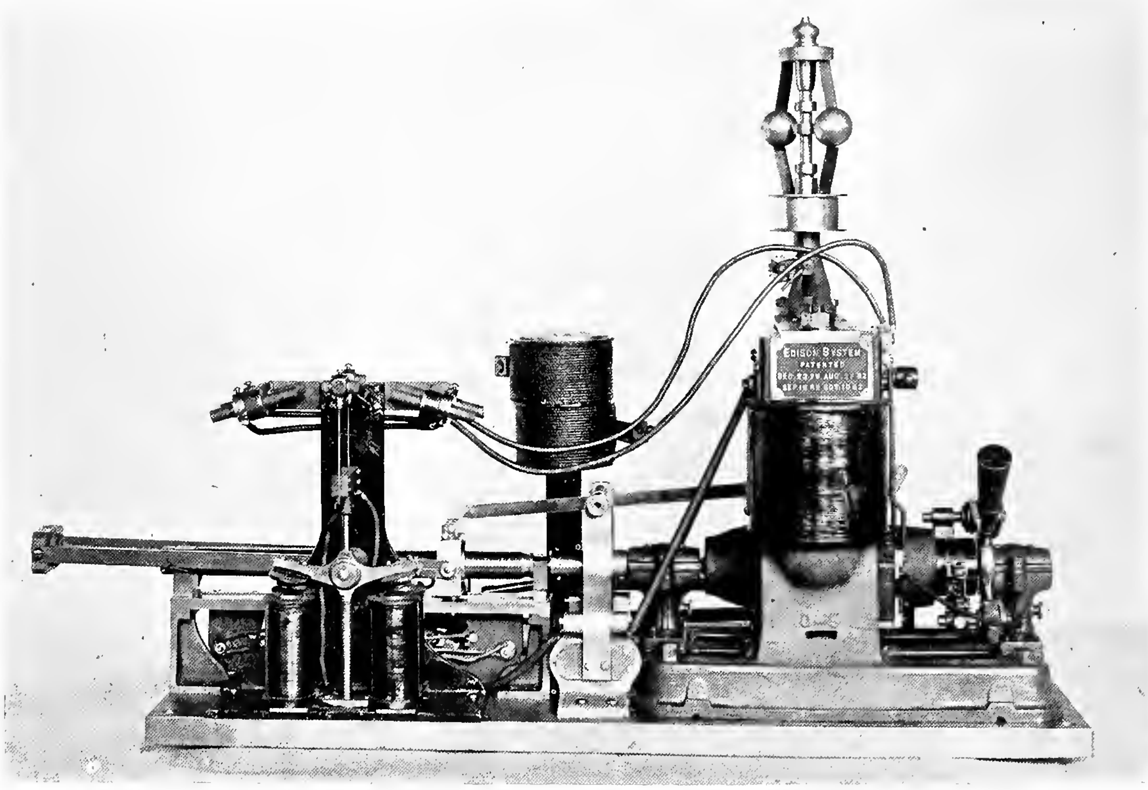
*Vol. iv, p. 85, et. seq.

the amount of load or to any variation in it, and which springs and levers instantly control the water with mechanical infallibility before the speed of the water wheel has been altered. The Girard governor is neither more nor less than a transmission dynamometer of the tortion type which admits of sufficient flexibility between the water wheel and the generator shaft to enable any variations in the speed of the armature to be transmitted direct to the nozzels before such variations have had time to affect the speed of the water wheels. The advantage of this arrangement over the one almost universally prevalent wherein the governor is actuated by a positive variation in the speed of the water wheel, is apparent.

In the Lighthipe water wheel governor, which is the invention of Mr. J. A. Lighthipe, chief engineer of the Pacific Coast offices of the General Electric Company, the actuation of the governor is had at the very source of the variation in speed, namely, by and from any increase or decrease in the electrical output of the generator, even before the speed of the armature can have been affected therefrom. In fact, as will appear, the actuating mechanism of the Lighthipe governor, as well as that of the armature, water wheel and fly wheel combination are caused to vary from their normal position and speed respectively, by the one simple cause evidenced in a change of amperage, or, in other words, by a change of load. Which, therefore, it may be asked, will more promptly respond to any change of amperage, the core of the governor solonoid, weighing but a few pounds and which is normally at rest, or the rotation of the armature-water and fly-wheel combination normally having a stored energy ofttimes reaching thousands upon thousands of foot-tons? In these ideas are embodied the underlying principles of the Lighthipe governor.

Marked improvements have been made in many details in the first form of the Lighthipe governor which was installed early in the summer of 1896 in the power plant of the Tuolumne County Elecetric Power & Light Company, of Sonora, Cal.*

This plant is still in operation with perfect satisfaction and since its installation has never failed to perform its duty without a single interruption of whatever nature. The latest Lighthipe governor installed, however, and which is illustrated herewith, is now governing the power plant of the Alaska Treadwell Gold Mining Company, at Douglas Island, Alaska. Briefly described, it consists of a fly ball Governor, belt-driven direct from the main shaft and whose sensitiveness is perfected by means of a lever controlled by the core of a solonoid that is cut into one side of the main circuit. The lever so actuated carries contact points making or breaking a battery circuit controlling a brake and an electro-magnetic double-pole, double-throw motor circuit switch, by means of which the one- half kilowatt Edison bi-polar series wound motor is operated in either direction. The armature shaft of this motor is coupled direct to



THE LIGHTHIPE GOVERNOR—REAR VIEW.

* For a description, see JOURNAL OF ELECTRICITY for August, 1896, Vol. 3, No. 2, p. 28.

a screw on which is a travelling nut with toggle connected to the water governing device, be it butterfly valve, deflector or hood.

To more minutely describe the Lighthipe governor, the double-pole double-throw motor switch is controlled in its action by a lever attached directly to the ball governor, the lever extending 18 ins. or more so as to gradually magnify the motion on the vertical rod of the governor. This lever carries the current to two contact points, the upper point energizing one set of magnets, shown on page 112, throwing the main double-pole double-throw switch in one direction, and the lower contact point throwing the switch in the other direction, reversing the motor.

Attached to a travelling nut on the screw extension of the armature shaft is a toggle working an adjustable wedge that raises and lowers the contact points as the gate is opened or shut. This adjustable relay prevents all tendency to see-saw.

Directly over the contact lever is a solonoid connected in series with one lead of the generator circuit, the pull of which is directly in proportion to the load on the machine. The effect of this is to pull directly against the centrifugal force of the balls of the governor, which makes contact immediately without waiting for any actual change of speed to occur. It also has a tendency to make the water wheel run faster at full load than at light load, and is in direct opposition to the action of the relay, which as it changes the points of contact, tends to run the generator slower at full load. The pull of this solonoid can be varied by an adjustable shunt.

At each end of the screw is an automatic cut-out and reverse switch introduced into the leads of the double throw switch magnets that and by means of which the current is cut from off the switch magnets when the nut has reached either end of the screw. This feature was introduced to keep the nut from jamming at the end of the screw in event of the shutting off of the water by the hand gate, when the governor keeps calling for more water to keep its speed, or at time of extreme overload.

Connected directly on to the frame of the shaft is a small electric brake which is "on" at all times while the motor is at rest. It works directly from an adjusable spring on the top and its action depends on a magnet in series with the motor. This action is as follows: As soon as the current is introduced into the motor by means of the double throw switch, the magnet releases the brake by pulling against the adjustable spring on the top. On the release of the switch the circuit of the magnet opens, releasing the spring which immediately applies the brake and stops the armature.

The electric circuit for the operation of the motor switch magnets and the brake magnet is taken from a primary battery consisting of about ten cells of common zinc carbon elements with a sal-ammoniac solution. These are put in series with one or more incandescent lamps, depending on the voltage of the generator, which keeps the battery under constant charge. In fact, the zinc carbon elements are used directly as a storage battery without the troubles attending the lead-sulphuric acid type of accumulators. Using such a small number of cells enables the bringing of the two contact points at the end of the lever to within 1-32 of an inch of the contact tip on the end of the lever, which in turn permits of great delicacy of adjustment.

The advantage of using a series motor direct for power is that if there is a slight change of load and a small call for water, the movement is made slowly. If, on the other hand, a sudden, heavy overload is placed on the generator, the motor accelerates in speed very rapidly and effects close regulation without excessive weight of fly wheel. As minor advantages might also be given the readiness with which it may be started and reversed, and the fact of there being no power used in the governor except when actually moving the gate. By using the combined action of the solonoid and relaying the contact points, results in regulation are accomplished that have never before been reached.

All details have been carefully worked out and tried for the application of the Lighthipe governor to any class of electric generator, whether for direct or alternating current work. In the latter, the solonoid is supplied with current from the secondary windings of a transformer, the primary of which consists of a few turns of heavy wire cut into the main circuit of the generator in series.

Transmission

THE LINE INSULATION OF 16,000 VOLTS.*

By Dr. C. H. Van Norden.

(A paper read before the Santa Cruz Convention of the Pacific Coast Electric Transmission Association. August 17, 1897.)

The problem of long distance transmission of power electrically is, of course, solely a question of high voltage and the satisfactory insulation of copper conductors. We are in this, simply imitating nature's thunderstorm methods and at the same time attempting to avoid her erratic practice of reckless conduction and haphazard discharge. Indeed, the first human intermeddling in long distance transmission was simply an endeavor, by lightning rods, to attract, restrain and conduct to earth, the sportive thunderbolt, regardless of the solemn declaration of the poet that

" . . . . Lightning does the will of God
And from its force nor doors nor locks,
Can shield you;"

and we are reminded comically of the protest of Abbe Nollet and his set in France, against Benjamin Franklin's proposal to protect buildings from the thunderstorm, which protest was in effect, that "to ward off Heaven's lightnings was as impious as for a child to shield itself from the chastening rod of a father."

Our commercial currents begin to approximate to the lightning's potential, but we are furnished with the very best possible lines of least resistence and with the fewest and least feasible outlets for escape by the way. Our thunderbolts are arc lights, incandescent lamps and the torque on the shafts of motors. We play Jupitor with results that would have immensely astonished the Roman augurs, and Heaven does not in consequence frown upon our impiety. The problem of high potential has been solved in transformers and high tension generators. Insulation, however, is a less satisfactory field of experiment and experience. To conduct even lightning is easy enough, but to prevent the leakage of a current of only a few thousand volts is difficult.

The following will simply give the solution of the problem of insulation as attempted by the Central California Electric Company, together with experiments accumulated:

The transmission line of the Central California Electric Company extends from Newcastle, in Placer County, in a nearly straight course southwesterly to the City of Sacramento and is a trifle more than twenty-eight miles long. For the first five miles the poles are of thirty foot sawed redwood and for the remainder of the distance they are of forty foot Washington cedar. The cross arms are five feet long and carry two pins of oak, three and one-half feet apart. A third pin is bolted on to a V-shaped iron strap, which latter is double lag-screwed into the top of the pole and thus the pins form on each pole an equilateral triangle. Three wires form the current and these are spiraled every mile.

The voltage at the power-house is but a little under 16,000 and insulators were selected from the petticoated porcelain variety. They are of the familiar Locke pattern, having enameled surfaces and three petticoats, the middle of which is longer than the other two, and the wires were fastened in the regulation way on the top groove, except where there was likely to be a lateral strain, in which case they were tied against the off side. At sharp corners there was substituted for the entire iron arrangement of the topmost pin, a block placed out of equilateral on the side of the apex of the pole opposite the strain. In places the high potential wires come within eight inches of each other, but without tendency to arc.

Only three annoyances have developed in connection with this arrangement, viz:

First—Some of our petticoats have been shot off by unprincipled, malevolent or thoughtless sportsmen—an evil which was easily remedied by the posting of a reward notice on every fifth pole.

Second—A few insulators (we are not sure of more than seventeen) were seriously defective on surface and split off and broke up under the stress of potential.

Third—A number of poles with defective insulators were burned in whole or in part, owing to the presence of sap, which acted as a conductor to the ground. It will be well to remark here that our line was erected in two different divisions full a year apart, the first eight miles to Rocklin having preceded the remaining twenty miles to Sacramento by fully a year. The poles of 1896 up to the beginning of the present dry season, were still more or less green. The burning always occurred in these and the defect was invariably in the topmost insulator when the ground was wet. The current escaped through slight cracks in the enamel and crossing the spongy, wet, inner, porcelain, followed the iron of the V-shaped support and penetrated the cedar by the lag screws to find in the sap a good conductor to the moist ground. This thread of current heated, charred and consumed the inflammable wood. Probably a dozen poles were wholly or in part destroyed, but strange to say, this seldom caused serious disarrangement to the wires or interruption to the service. Indeed, we generally learned of the untoward occurrnces, not from our switchboard instruments, but from locomotive engineers and freight car conductors, or from telephone messages from villages in the vicinity of the disaster. No pins have been burned or even charred by play of rain drops or through spider webs, and this is doubtless owing to the length of the middle petticoat.

We have found that by the assistance of a portable telephone a defective insulator can be exchanged with a shut down on the line of from five to nine minutes. The entire pole line is inspected and every insulator scrutinized each day.

Our firm conviction is that 30,000 volts can be easily restrained with our present insulators, provided the pins are of approved materials or that both arms and pins are boiled in paraffine and then soaked in P. & B. paint. The poles should be of redwood because this will endure a higher degree of heat than cedar without combustion, not to speak of the fact that redwood offers for the same reason greater resistance to stubble and forest fires.

In conclusion we believe that the art of insulation is in its incipiency and we see no reason to doubt that much higher potential than 30,000 volts can and will be used and controlled.

INSULATORS FOR ELECTRIC POWER TRANSMISSIONS.*

By T. A. W. Shock.

(A paper read before the Santa Cruz Convention of the Pacific Coast Electric Transmission Association, August 17, 1897.)

The advent of electric transmission of power into the electrical field has made the question of line insulation considerable of a study. The possibilities of a shut down, especially in instances where the plant is delivering a twenty-four hour service, are worthy of serious consideration and the object of every manager is to reduce these possibilities to a minimum. The high voltages at which transmission lines are now being run and the still higher voltages at which they will soon be operated, makes the insulator a very important factor in the successful insulation and operation of electrical transmission plants.

The climatic conditions must be considered in every case. In countries where snow and ice are unknown, an insulator might stand heavy rains, but it might not stand the heavy strains to be brought upon it by the atmospheric rigors of other localities. Where snow and ice are prevalent for four or five months of the year, the question of proper line insulation becomes a serious problem, for the insulator has not only to resist the passage of current through the ground, but must be sufficiently homogenious to withstand the extra weight of ice, sleet and snow that would adhere to the wire. The heavy snow and sleet storms prevelent in the East instance the great strain that insulators might be subjected to.

In California these conditions do not exist except

in cases where the source of power is located above the snow line. This is a condition to be considered, as the future of the transmission of power in California lies to a certain extent in the utilization of streams that have their sources well up in the mountains where snows prevail each winter. In localities subject to heavy rain, it is necessary to use an insulator that will shed the rain quickly, and at the same time have an outside petticoat sufficiently large to protect the pin from moisture.

On July 16th, 1894, the Sacramento Eelectric, Gas & Railway Company, with which the writer was connected, commenced transmiting electric power from Folsom to Sacramento, a distance of twenty-two and one-half miles. During the succeeding winter the rains were quite heavy and some difficulty was experienced from punctured insulators and burned pins. The line was equipped with two styles of porcelain insulators, viz: A triple, vertical petticoat, and a later type consisting of a triple flare petticoat. The former gave us all the trouble the first year and the latter most of the trouble the second year of operation.

In most of the cases the pin was burned at the lower edge of the inner petticoat and only in a very few cases was the pin burned at the top. Sometimes the insulator was punctured at the top, but in most of the insulators the trouble that developed seemed to be at the lower edge of the thinner pettiocat close to the pin where the glazing had been removed in baking.

In examining the insulators taken off the line I found in some cases that although the puncture showed at the top it did not appear to carry all the way down. Generally cracks were shown at the top of the insulator which followed all the way down to the bottom, thus showing a lack of vitrification in moulding the insulator, as the cracks were, in some cases, simply covered by the glazing. Invariably the glazing was off where the insulator rested when baking, and this was also in eveidence on many of the new insulators. Both styles of these insulators are now in use on the transmission line between Folsom and Sacramento. This experience appears to show that it is not so much in the shape of the insulator as it is in the manner in which it is made. A dozen china Locke insulators were placed on the line last winter and so far as is known they have given quite good satisfaction.

In an insulator recently taken from the lines of the Sacramento Electric, Gas & Railway Company and tested as to its porosity by immersing it in red ink, the writer found that the ink worked its way through the material to its surface where the glazing was worn off, showing that when the glazing was removed there was sufficient porosity to allow leakage through the material to the inner petticoat and thus to the pin. In most cases where the insulators were taken off the line they were removed from portions where bare copper conductors were used and these insulators showed that the glazing was worn off where the wire came in contact with it by the working of the wire during winds or heavy storms. The glazing having been worn off, the current easily found its way to the pin, which meantime was also burned. This experience also appears to show that an extra heavy glazed surface is required and that as perfect homogeneity in the material is necessary in order to prevent leakage.

In designing an insulator the object is to get the longest insulating surface in the smallest number of square inches and to secure the cheapest insulator that can be manufactured to meet the existing conditions. The cost of insulators is a very important factor in the installation of electric transmission lines. The first cost has to be considered as against possible interruptions that might occur to the line.

Many experiments have been and are being made on glass insulators for high potential currents, and to my knowledge no tests in actual service have as yet been reported. In my opinion the Locke two-part insulator meets the conditions for high insulation as well as any insulator on the market. In this the outer shell is of china, which presents a high insulating surface, as well as mechanical and electrical strength and the inner or center shell is of glass or china, to afford further insulation. This makes it possible to obtain a more thorough vitrification than would be obtained in one solid insulator and in addition, affords four thicknesses of glazing in further insulation. The cost of this insulator, of course, will be a factor, but this is certainly offset by its higher insulating properties.

THE CONSTRUCTION OF TRANSMISSION LINES.*

By John S. Eastwood.

(A paper read before the Santa Cruz Convention of the Pacific Coast Electric Transmission Association, August 17, 1897.)

In presenting the following elementary notes, I beg the indulgence of the members of this association for, while there may be nothing new in this paper to those who have built transmission lines and whose experiences may exceed that of the writer in all directions, if in any way I shall have added to the practical literature on the subject and shall have given information to those contemplating new work, I shall feel amply repaid.

When the plans for a transmission plant are under consideration, it may be taken as a rule that ordinarily the plans and specifications of the pole line will receive less consideration than those for any other part of the plant. This is due largely to the fact that the hydraulic and electrical equipments are accompanied by the plans and specifications of the engineers of the manufacturing companies, the apparatus being guaranteed as to workmanship and efficiency, while the pole line material, being usually furnished by a number of different parties, is frequently thrown together haphazard under the direction of a lineman and a carpenter. This laxness is largely due to the fact that literature bearing on line construction pratices are extremely meager.

The modern electric transmission line is an evolution of the telegraph line and the later telephone and electric lighting distribution lines, and the tendency has been to follow the loose methods and bad workmanship of the earlier constructions. Like any other part of an electrical transmission plant, the pole line should be designed to fit local conditions, but there remains general points that should be carried out in all lines. In the earlier discussions of the problems of power transmission the great question of doubt was in the maintenance of uninterrupted service on the line. The general concensus of opinion was that the dangers of interruption would be in direct proportion to the length of the line, but in practice this feature of transmission work will depend, to a very large degree, on the character of the line constructions. The specifications of an electrical transmission line should

be based on the same sound engineering principles as those of any other permanent work, and the line should be so designed as to cost the least for maintenance, coupled with economic cost of construction. Good engineering consists of good judgment, mingled with technical knowledge, and good engineering work consists of construction wherein all the factors bearing on the case are given their proper value in the resulting equation and the results are embodied in a work costing the least money for construction consistent with the most economical maintenance.

The general features entering into the problem of line engineering are line location, line materials and line construction. In weighing these factors, they should be considered in their relation to the prime idea of electrical transmission, namely, permanent continuity of service.

Consider first the factor of line location, one of the most important features of which is that of the alignment. A general rule that is wise to follow when at all possible, is one similar to that laid down by the Czar, who, when asked to locate the route for a railway from St. Petersburg to Moscow, did so by drawing on the map with a rule a straight line between the two cities.

The factors that enter into the problem of location to prevent straight alignment are found in such impassable barriers as very wide streams, lakes, inaccessible canons and mountains, and, in many cases, the difficulty and expense of obtaining rights of way. In computing the relative value of these factors, they must be weighed by a consideration of the additional cost of line, the additional cost of maintaining, the additional drop in the voltage of the line by reason of length added, the additional cost of angles and of the added line, and the cost of the right-of-way. Another feature of importance brought out by the experience with the San Joaquin Electric Company's lines is that the danger of malicious interruption is very largely decreased by having lines remote from public highways. Our line has its general direction of south 30 degrees west, and we found that we could much better pay $250 per mile for right-of- way than to take a free right-of-way on the section line around the lands in question, even when counting in only the additional cost of the line and leaving out the features of added drop, angles and maintenance.

In the location of the line over rolling and hilly ground there is very little to be gained by one location over another, and as a rule it is better to keep as straight as possible, regardless of the character of the ground. On very rough ground there is a slightly increased cost to be added for the delivery of line material in difficult places, but this cost will be more than offset by the shortening of the line. Measurements for line work should be taken on the slope of the ground as that represents the true distance. In running over undulating ground, it will be found that the upward pull will occur on very few of the poles as the hill slopes are almost all vertical curves, giving a downward pull: the upward pull occurring on one or two poles at the ravine crossings. All sharp, horizontal angles should be avoided in locating transmission lines. If necessary to turn a corner at right angles, the angles should be broken in two or three parts and the poles set close together to take up the additional strain.

As to the next question, the selection of line material is one of vital importance in line construction, as upon it, more than any other feature depends the life of the line and, consequently, the cost of maintenance. A wise rule to follow in this regard is that the best material obtainable is none too good. The vital element in the life of the line is in the selection of the poles. We of the Pacific Coast are exceedingly fortunate in having an abundant variety of excellent materials for poles from which to choose. In selecting our poles the central idea was that of making the most permanent line and after many years of close observation the conclusion has been reached that the sap-wood of any variety of timber is absolutely worthless as to its lasting qualities in the ground, and that its use is a menace to any transmission line in that it is liable to be counted on for strength, which disappears in a few years, and besides, the decaying portion leaves the pole loose in the ground, subjecting it to greater strains and leading to the decay of the more resistant heart-wood. Having seen round cedar telegraph poles along the line of the Southern Pacific railway that have rotted entirely off after having been in the ground for twelve years and having seen sawed redwood poles that were still sound after standing in the ground for forty years,it did not take long to reach the decision to use sawed redwood poles, especially as the price was nearly alike on equal sizes. As the poles for most lines are ordered but a short time before being put to use and are delivered direct from the woods, the use of tar on the butts is of very doubtful value, as applying it at that time encloses all the sap contained in the green wood and moreover the tar will not penetrate the wood to preserve it. A much better procedure is to set the pole in the line and after a couple of years of seasoning to dig away two feet or so of earth, then clean the pole and apply the tar hot, during the dry season. This method will afford ample protection, as the decay is greatest at or near the surface and for about two feet downward.

It is well to bear in mind that when a pole becomes rotten there are no means available of ascertaining its exact condition and it will surely give way at some time of unusual strain when least expected. Were it possible to determine the condition of a decaying pole it might be replaced by a new one without interruption of service, but the great difficulty is that it is impossible to locate the weakness until it has manifested itself in a breakdown. In the matter of the size and length of poles that should be used, the ultimate weight of the line, the length of spans, and the wind strains will determine the size to be required for safety, while the length is a matter that is determined principally by franchise requirements. As to the height of wires, the high line has the advantage of reducing earth induction and of avoiding malicious disturbance, but, on the other hand, it possesses the disadvantage of increased leverage on the butts of the poles and of increased cost.

The cross arms should be made of the toughest timber available, to avoid splitting and not warp. They should be painted with lead and oil paint to prevent weathering and cracking, which is a weak point because of the holes they contain and of their being subject to constantly changing srains. The cross arms of the San Joaquin Electric Company are made of Oregon pine, 4x5 inches, dressed and rounded on the upper side with holes for six pins and for the pole and brace bolts. Bore only such holes for pins as are needed, as each hole is a source of weakness. One great defect in putting on cross arms is that usually the bolt washers are too small and crush into the wood, weakening the arm. The strains on cross arms

are mainly due to the tortional strain on the pin, which generally exceeds the weight to be borne, hence cross arms should be nearly square in section. Braces of 1x1¾ inch iron, bent to give a square seat on the cross arm and poles, bolted with a ⅝ inch bolt through the cross arm and lag bolted to the pole, have proven very effective.

The question of pins and insulators is the most intricate problem of line construction. Pins are a mechanical device which can be made to meet the requirement of furnishing a stable support for the insulator. They should have a stem that will not pull out of the cross arm, a base or shoulder to resist lateral strain and a thread to securely hold the insulator. These conditions are best met by a composite pin consisting of a bolt passed through a wooden-threaded pin with a broad base, or, which is better, a lead thread on a bolt supported on a metal base and tightened by a nut and broad washer under the cross arm. One of the great objections to wooden pins is that in order to give them strength, a very large hole must be bored through the cross arm, which weakens it, and that during the dry season the pins shrink and loosen while during the wet season they swell and crack the cross arms, hence the great advantage of a bolt lies in the fact that it possesses neither of these defects and always remains in place. Pins should never be made so that the threaded portion touches the insulator, as it is liable to expand and split it.

The insulator is the most important feature of line construction and is now receiving universal attention. The experience of the few years of high tension transmission have taught that it is only the mixture of insulators and water that has given special trouble. Almost any type of insulator will make a fair weather insulator, but fogs and storms and the wettest kind of weather must be prepared for, and manifestly the type of insulator that will absolutely insure a dry gap between the lines and the ground under all possible climatic conditions, is the one being sought for. Great stress has been laid on points in various insulators concerning the amount of insulated surface the current would have to travel over to reach the pins, but the vital point of imperviousness to water has been, to a great extent, overlooked. In California we have all the conditions of weather that exist anywhere and in some localities its climatic conditions are worse, so far as long duration is concerned, than in the western climates, and especially is this so in the occurrence of daily and long continued sea and land fogs. The portion of our lines on the plains were submerged in fog for fifteen consecutive days and nights last winter, ending with a diverging rain. These fogs drifted slowly along the ground and condensed on all intervening objects, so that everything that would absorb moisture, became thoroughly water-logged on the side facing the breeze, though they sometimes remained comparatively dry on the leeward side.

Viewing the problem in this practical way, leads to the point of determining the question of insulator design from a mechanical standpoint. The insulator must be impervious to water, as it must act as a water shed or roof to keep the body of the insulator dry. It must, therefore, have a dry gap between the roof and the pin and it must be of sufficient mechanical strength to resist the strains to which the line subjects it.

Other details of construction require careful consideration. The right-of-way should be cleared of all brush and grass at least ten feet on each side of the line and all trees of whatever kind that might reach the line in falling should be cut down. The right-of-way should be at least twenty feet in width so as to give ample room for construction, maintenance, and the protection of the line from fires. The distance between poles must be determined from the topoghaphy of the country, from the size of the poles and the weight to be carried on them as well as from other strains. The excavation of pole holes forms an important element in the cost of line construction and the method to be pursued depends upon the character of the ground. A large proportion of the country crossed by the lines of the San Joaquin Electric Company is of hard or soft granite, rock, or hard pan overlaid by a shallow bed of earth and the use of giant powder proved to be the cheapest means of loosening both rock and earth. Rock was loosened by two shots of giant powder while in earth surface, the top was removed by ordinary means and the bottom loosened by a single shot, consisting of a stick or a portion of a stick of giant powder put into the bottom of a hole drilled by means of a churn drill operated by two men.

It is difficult to get insulators erected properly on wooden pins, as the pins must be nailed in during dry weather and insulators with a single groove for the line wire will often lack a quarter of a turn when fully screwed in, of being inalignment, in which case the lineman will turn the insulator back until the groove is in line, making the insulator loose on the pin. The San Joaquin Electric Company has had as much line trouble from this one cause as from all others combined, and while it does not often short circuit the line, it necessitates the shutting down of one line to reset the insulator. Obviously, if bolted pins are used the insulator can be screwed down tight and the nut of the pin tightened when the insulator is in alignment.

INSULATORS FOR USE ON HIGH VOLTAGES.*

By Henry D. Sears.

(A paper read before the Santa Cruz Convention of the Pacific Coast Electric Transmission Association, August 17, 1897.)

The apparatus for the development and conversion of electricity at high voltages, having reached a satisfactory degree of perfection, the question to be considered is that of the line. The only problem here is that of insulation. Bare wire is universally used and thus the entire burden is thrown on the insulating supports which carry the conductors and absolute and entire dependence must be placed on them. It is therefore evident that the question of insulators is of the most vital importance.

To properly serve their purpose these insulators should fulfill a number of conditions.

1. They should be made of an absolute non-conductor.
2. They should not absorb moisture.
3. They should be unaffected by exposure to atmospheric influences.
4. They should be of great strength.
5. They should be made of material to the surface of which mositure, dust, smoke, etc., will not adhere.
6. They should be of such shape as to readily shed water.

7. They should be of such size and shape as to reduce surface leakage to a minimum.

The only materials seriously considered for the manufacture of insulators, to fulfill the above conditions, are porcelain and glass. In two very important points porcelain is so far superior that it has been adopted on every line which is actually transmitting power in quantity. These two points are,

I. Strength and brittleness. It takes a much harder blow to break a piece of porcelain than an equivalent piece of glass, and when the blow is hard enough to be effective, porcelain merely chips while glass completely shatters. Insulators are the special targets for small boys with stones and for larger ones with fire arms. A glass insulator when struck flies to pieces and allows the conductor to drop on to the cross-arm, while a porcelain insulator possibly chips but stays on the pin and continues to hold the wire in place. In practice, boys and marksmen give up trying to break the porcelain insulators after a few unsuccessful attempts. Line repairs are dangerous and difficult to make on high potential circuits, besides which they are very expensive and interruption to the service is a most serious matter.

II. Hygroscopic properties. It is a well established fact that moisture, smoke and gases prevalent in the atmosphere will condense far more rapidly and in greater volume on a glass surface than on a porcelain surface, and further, that they will adhere more tenaciously to glass than to porcelain. Glass insulators when exposed to the weather for a time, become coated with a conducting film. The surface leakage is thereby increased and continues to grow worse. On porcelain insulators, the coating so formed is much less and washes off clean during rainfalls.

There is considerable misunderstanding in reference to the meaning of the word "porcelain". A piece of true porcelain is an absolutely vitreous and homogeneous mass throughout. The body is as non-absorbent and possesses just the same insulating qualities as the glaze. A great deal of what is called porcelain is not all of this description; the body of the ware is porous and when exposed to moisture will readily absorb it and be thoroughly permeated with it. Insulators made of such material as this, when covered with a reasonably good glaze, have been used in a great deal of electrical work, but they are worse than useless for out-door work when exposed to high voltages. In dry weather they serve their purpose fairly well but in wet weather give serious trouble.

In confirmation of the above statements the following extracts from standard authorities are quoted. These were written with reference to the insulation of telegraph lines and therefore apply with much greater force to lines operated at high voltages and carrying heavy currents.

From Geo. B. Prescott's "Electricity and the Electric Telegraph:" "Glass is more extensively used in "America than any other. The principal objections "to it are the property it possesses of becoming coated "with a film of moisture in certain states of the atmos-"phere, and its liability to fracture. The first of these "is practically more serious than the other and thus "far no effectual means of overcoming it has been dis-"covered. The large white porcelain insulators used "on the continent of Europe appear to be superior to "those of glass, but are quite expensive and this fact, "perhaps, as much as anything else, has prevented "their more general use in other countries."

From Fleming Jenkin's "Electricity and Magnetism:" "Glass of certain kinds offers the greatest re-"sistance to conduction through its substance of any "known material, but it does not answer well for tele-"graphic insulation, because the surface conduction "plays by far the greatest part in the leakage from a "line, and glass is highly hygroscopic, i. e., it will be "found covered with a moist film in most states of the "weather. Porcelain of certain qualities insulates "well; it is not nearly so hygroscopic as glass, and the "rain runs readily from its highly glazed surface."

From Preece & Sivewright's "Telegraphy": "Nothing has yet been found which will perfectly in-"sulate, nor can a theoretically perfect body in this re-"spect ever be looked for. Porous substances are in-"admissible on account of their absorbing moisture " too readily and being thus transformed into conduc-"tors. A glaze or surface can be imparted to them, "but recourse should never be had to this; only upon "bodies which are in every respect suitable should a "glaze be put, and then for the purpose of forming a "fine, hard surface. A smooth, hard surface is indis-"pensable; with it there is no danger of the wire being "worn through by friction, nor can dust and dirt ad-"here to the insulator so firmly as not to be washed "off by a good shower of rain.

"Glass possesses both of the qualifications named "above, viz., high resistance to the passage of electric-"ity, and a smooth, hard surface; but along with these "it has one inherent disadvantage which is fatal to its "employment as an insulator. It is a very hygroscopic "body, that is to say, it condenses the moisture from "the air very readily and in a climate such as that of "England it is for this reason altogether unsuitable. "The surface of a glass insulator is almost always "covered more or less with a thin conducting film of "moisture. It is moreover very brittle.

"Porcelain has been and is still largely employed in "the manufacture of insulators. Its insulating power "is high; it possesses a good, smooth surface; and pro-"vided it has been perfectly vitrified throughout so as "to be homogeneous, impervious to moisture, and free "from flaws, it is eminently adapted for the formation "of an insulator. Porcelain, however, varies very "much in its quality, and unless the manufacture has "been thoroughly carried out with the greatest care, "no reliance can be placed upon it."

It is a comparatively simple matter to make small pieces, but quite a different matter to make large, thick pieces of complicated shape which shall possess the qualities of true porcelain. This problem has, however, been solved by the manufacture of porcelains which fulfill the definition in all respects and insulators are now made which will not absorb moisture, (even when unglazed) if completely immersed in water, and show just as high an electrical resistance when unglazed as when glazed. The purpose of glazing them is only to obtain a smooth, glossy surface and not to keep out moisture. If carefully investigated it will be found to be a fact that; wherever high potential insulators have proven satisfactory, they have been made of this character of porcelain; wherever they have given trouble they have been of inferior quality.

From careful experiments it has been found that a salt water test of 40,000 volts will detect any defects existing in an insulator and if it stands this without being punctured, there is no danger of its failing on the line even under the most severe conditions. All high grade porcelain insulators are now subjected to test during the process of manufacture. In the un-

glazed state they are stood on their heads in an iron tank, which is filled with salt water to within about an inch of the rims of the outer petticoats, and salt water is poured into the pin holes; one terminal is connected to the tank, the other placed successively in the pin holes of the insulators under test and the voltage applied. All insulators which are punctured are rejected, the others are glazed and packed for shipmnt.

All sizes are subjected to the same test and as far as danger of puncturing on the line is concerned the smallest size would be suitable even for the highest voltages. Other considerations come in, however. As the voltage is raised the tendency to a disruptive discharge through the air from tie wire to pin is increased. This must be guarded against by increasing the height and diameter of the insulators. Furthermore, the higher the voltage the greater is the liability of surface leakage. This is lessened by increasing the surface distance from tie wire to pin, which is accomplished by increasing the size of the insulators and making them "triple petticoat."

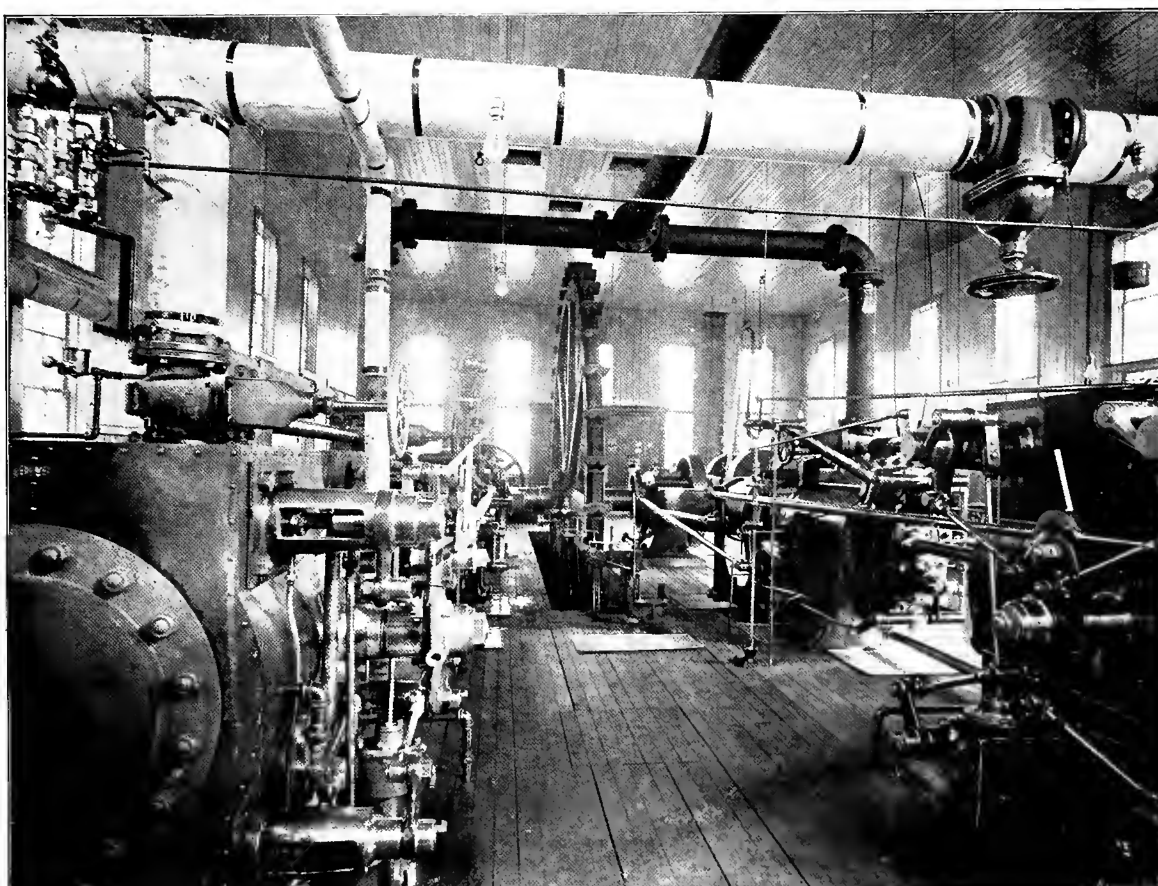
To determine the style of insulators to be used in any case careful consideration must be given to the working voltage adopted and to the climatic conditions of the country in which the line is located. Insulators which might give entire satisfaction on a line operated at 20,000 volts in a dry climate might not be safely used at over 10,000 volts in a rainy or more especially, a foggy climate. It is poor economy to adopt a small insulator simply for the sake of some saving in first cost and this is of little importance compared with the successful operation of the line under all conditions of weather.

SOME BIG PELTON WHEELS.

The success attending the installation of the 18-foot Cobb truss wheel for direct connection to air compressors at the North Star Mine, in Nevada county, Cal., during the latter part of 1895, gave an impetus to the erection of similar Pelton wheels that has resulted in several interesting installations, the most recent being a 19-foot wheel in the Gwin mine, in Amador county.

The largest and in many respects the most interesting wheel of this type which has thus far been installed is that of the Alaska-Treadwell Gold Mining Company and which is illustrated on this page. This wheel was built up of cast iron with Pelton buckets of phosphor bronze and has a diameter of twenty-two feet, in running at its normal speed of 75 revolutions per minute, giving a peripheral speed of nearly 5800 feet per minute. It is being operated under an effective head of 480 feet and, when supplied with a four inch stream of water which forms the maximum it is capable of handling, will deliver 700 horse power. The wheel is governed by a Pelton hydraulic governor which effects regulation by a combination of speed and pressure.

This large wheel is direct connected to a duplex air compressor having 24x36 air cylinders and, as will be noted by reference to the illustration, the wheel is so designed that it is possible to connect it to a cross-compound Corliss engine, 22x38x36, so that the compressor may be operated by steam during those seasons of the year when the water supply is inadequate to operate the Pelton wheel. When so operated the water wheel serves as fly wheel for the engine and compressor.



A TWENTY-TWO-FOOT PELTON WHEEL.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

OFFICIAL ORGAN OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

SUBSCRIPTION PAYABLE IN ADVANCE. TERMS—DOMESTIC, ONE DOLLAR PER YEAR; FOREIGN, TWO DOLLARS PER YEAR. RATES FOR ADVERTISING ARE MODERATE.

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EDITORIAL.

THE ELECTRIC TRANSMISSION ASSOCIATION.

While the Pacific Coast Electrical Transmission Association has not had time to settle down to a working basis as yet, and although no stenographic report of its deliberations are to be taken until its October meeting, still the papers read before the Santa Cruz convention and initially published elsewhere in this issue, suggest a few of the valuable experiences which will be brought out by this most important body. One will read with deep interest of the burning of defective poles by leakages from the 16,000 volts transmission of the Central California Electric Company; of the puncturing of defective insulators and the chafing-off of the glaze of insulators in the Folsom-Sacramento plant; of the fruits of the experiences derived in the construction of the pole line of the Fresno transmission and of the points given concerning requisites in the manufacture of high tension insulators. With greater satisfaction yet will be noted through all the papers that the troubles which have beset transmission lines may now be counted as of the past, for even that portion of Mr. Eastwood's paper which tells of the submerging of the pole line in a sea of dripping fog for fifteen consecutive days and nights, demonstrates the fact that in its present state, the electric transmission of power rests on a basis so thoroughly sound as to compare favorably with any other form of power in the points of reliability and continuity of service.

A rapidly growing industry is like a new mining country in that in it there are constantly being uncovered fresh leads for exploration, and the electric transmission industry presents no exception to the rule. Indeed just as the elements of doubt that formerly existed concerning many details of electric power transmission had been dissipated, the determination to use far higher potentials and to transmit power far greater distances, introduced new elements that in turn necessitates further experiment and which bring about other fields of most profitable discussion.

The Transmission Association will ever be introducing new features, new facts, new experiences and new practical solutions of electrical problems and no man who is in any way concerned in the progress of electricity in this direction can afford to overlook the information its papers and discussions imparts.

A MATTER OF EQUITY.

Brief but pointed references to two subjects of vital concern to central station managers appear under Passing Comment elsewhere in this issue, the subjects being, "Load Factors and Profits" and "On The Determination of Meter Rates."

The electric lighting fraternity has long apprecited the disadvantage imposed upon it by reason of an exigency of its business which necessitates the installation of machinery of sufficient capacity to supply the maximum demand of but an hour or so daily, and which enforces the idleness of the bulk of the plant during the greater portion of the time. Ideal conditions are found in the station which has an unvarying load for 24 hours daily, wherein there is no idle investment and the entire plant is earning money all the time. Such a plant would have a load factor of 100 per cent, that is, the ratio between its average load for the day and its maximum capacity would be unity. In contrast with this the prevailing load factor of from 15 per cent to 20 per cent in European stations and from 25 per cent to 40 per cent in American stations, discloses an unsatisfactory situation.

At present it seems as though electric lighting stations are doomed to labor under the burdens of low load factors, for a way is not known by which the current available during light loads can be sold at such periods and in such bulks as will satisfactorily accommodate itself to the evening-up of the load line. The pecuniary loss to the station of making a uniform charge for electricity regardless of whether sold during the periods of light or heavy load is very forcibly shown in one of the articles referred to, but one realizes in the light of such demonstration that the present universal method of selling electrical energy without regard to the period of load line, is unbusinesslike and amateurish, in view of which it certainly seems that strenuous efforts should be exerted to overcome the objections which appear to bar the way to the adoption of a more rational and equitable method of determining the value of electric service rendered.

The adoption of the sliding scale as proposed would however, be in the nature of a revolutionizing innova-

tion, which, though eminently desirable may be inadvisable. More probably will the question find a soluton through gradual processes such as would follow the adoption of a method similar to that suggested by Mr. Beal for the determination of meter rates that shall be equitable to both consumer and producer. Though the formula takes no cognizance of the time of day during which service is rendered or of the load factor directly, it does not overlook an essential feature of continuity of service, and its purport to reduce the price of mechanical horse-power to an equivalent cost per kilowatt hour, will prove advantageous in assuring its more ready adoption by the consumer.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

ON THE DETERMINATION OF METER RATES.

The manifest unfairness to stations supplying light and power service in selling energy at uniform rates to consumers regardless of the length of the period of daily service, or in other words, of the continuity of service, has suggested to Mr. C. N. Beal, Secretary and Treasurer of the Power Development Company of Bakersfield, Cal., the formula given below and which will be found of extreme value in deriving a rate for electric service that will be equitable alike to consumer and electric company.

Central station managers know the total cost of producing energy from which they estimate that price per horse power per year at which they can sell electric current so as to afford a reasonable profit. Generally the consumer buys motors in terms of horse power, and energy by meter in terms of kilowatt hours, and as popular usage has fixed the cost of power in terms of horse-power per year, there is necessity for reducing the value of horse-power to an equivalent expression in kilowatt hours.

The mode suggested for reducing the cost of mechanical horse-power to an equivalent price per kilowatt hour, is shown in the following formula:—

$$\frac{\text{Cents per HP per year}}{\frac{746}{p} \times \frac{d \times h}{100}} = \text{Cents per kw hour.}$$

where p represents the efficiency of the motor or translating device; d, the number of working days per year; and h, the number of working hours per day.

Obviously the formula is adapted to any condition that may arise relative to efficiency or period of service.

LOAD FACTORS AND PROFITS.

Mr. Arthur Vaughan Abbott, in an instructive article on "Power Station Load Lines," in Cassier's Magazine for September, illustrates very forcibly the influence of the power factor of a station on its earning capacity in a striking example which indicates the expediency of arranging a sliding scale by which the energy delivered to a customer shall be metered in such a way as to note the time in which the maximum load occurs, as well as the amount, and arranging the scale of charges therefrom so as to stimulate uniform consumption.

In the supposititious example presented, it is assumed that there are two customers, A and B, each consuming 1000 kilowatt hours per month, but that A takes a steady supply for twenty hours per day, while B's demand is compressed into one and one-half hours per diem. Assuming also that the average cost of equipment is $300 per kilowatt of station capacity, 16 per cent interest and depreciation on cost of plant, 6 cents per kilowatt hour as the cost of energy delivered and 10 cents per kilowatt hour as the selling price, the accounts of A and B will stand as follows:

$\frac{1000}{30 \times 20}$ = 1.666 kw. hrs per hour, which is A's demand.

1.666x$300,— say $500 as cost of station to supply A.

Interest and depreciation, $500x16 per cent..	$ 80.00
Cost of energy, 12,000 kw. hrs per year, at 6c.	720.00
Total annual cost to supply A....	1200.00
Income, 12,000 kw. hrs. to 10c..	1200.00
Profit....	$ 400.00

$\frac{1000}{30 \times 1.5}$ = 22.222 kw. hrs per hour, which is B's demand.

22.222x$300—$6,666, as cost of station plant to supply B.

Interest and depreciation, $6,666x16 per cent.	$1066.66
Cost of energy, 12,000 kw. hrs. per year at 6c.	720.00
Total annual cost to supply B..	$1786.66
Income, 12,000 kw. hrs. at 10c..	1200.00
Loss....	$ 586.66

In both these examples the same amount of energy is sold at the same gross income, yet in the first instance there is a profit of $400 and in the latter a loss of nearly $600. An equitable charge that should be made to consumers A and B respectively may be derived in the formula:

$K \left(c + P + \frac{Ci}{8760\,p} \right)$ in which C represents the cost of installation per kilowatt, in the rate of interest and depreciation, c the cost per kilowatt hour for fuel, labor supplies, lost energy, etc., to deliver one kilowatt hour to the consumer; p the percentage of total time that each consumer demands supply; and K the number of kilowatt hours consumed per annum. The formula shows that equitable annual charges would be $1279.20 for A, returning a profit of $479.20, and $2251.20 for B, returning a profit of $464.54.

DRIVING DYNAMOS BY GAS ENGINES.

The higher efficiency of gas when used as power for the production of electric light, rather than as an illuminant direct, has received some attention of late, but that the subject is not a new one is evidenced by some of the circulars of the now defunct Pacific Electrical Storage Company, which so thoroughly pioneered the storage of electricity on the Pacific Coast and against which it can only be charged technically that it was far in advance of its period.

This company, under the management of Mr. James Armstrong, installed a number of meritorious storage plants, not the least interesting among which were several deriving power from gas engines wherein the cost of gas so consumed as fuel was proven to be less than the cost of an equal illumination by the burning of gas direct. This experience led to the publication, in an advertising way, of the following interesting statement which originally appeared early in 1891:

"In San Francisco it costs 8 mills to burn one 4-foot gas-jet for one hour, while with the storage battery, one 16-c. p. incandescent lamp burning one hour consumes 5½ mills' worth of

gas as fuel in its production. If you burn fifty 4-foot gas-jets for two hours each night, you pay 80 cents for the light given, while, with the storage system, fifty 16-c. p. lamps are burned two hours at a cost of 55 cents for the gas and attendant expenses of generating your own electricity. If you wish to get an amount of gaslight equivalent to the light of fifty "honest" 16-candle-power incandescent lamps, you must burn fifty 6-foot gas-jets, costing you $1.20 for two hours."

Literary.

SOME SECRETS OF SUCCESS.

There were just three passengers in that little Pullman car that drew out from Salida, Colorado, over the narrow gauge road of the Rio Grande route, one October morning as I returned from the Columbian Exposition. One was a fussy old lady, with a liberal assortment of traveling bags, and a canary frightened half to death. She has now almost passed from memory. The second,—a stalwart fellow in magnificent manhood and who appeared the personification of health, happiness, and prosperity—I can never forget. He told me neither his name nor his business; at first I thought him to be a journalist, probably because he resembled one I once knew. Later, I concluded I did not know anything about it. He certainly had every characteristic of a gentleman of refinement; it was evident that he had been successful in business, and he certainly made a lasting impression on the third passenger—myself. Men who travel in Pullmans would seldom become acquainted but for the "smoker." There was where we met, and soon engaged in conversation. As the morning wore on the commonplace talk of the scenery, the weather, and other ordinary themes became desultory. Then the World's Fair was discussed, and in alluding to the gloomy outlook that existed during the first months of the Exposition, I observed that Chicago had certainly met the emergency and had achieved a grand success from apparent failure.

"Chicago," he replied, "is a city evincing that determination and energy which alone can make success from failures. But few cities are so endowed; and as with cities, so with men. How deplorable is the fact that the great bulk of humanity does not avail itself of those attributes, born in every man yet dormant in most of them, which dictate ways for the betterment of its condition. To my mind, if a man makes a failure of his business or of his life, generally, he alone is responsible for it. This truth is an odious one to those in adversity, and though that responsibility be shirked and denied, it will still prevail directly or indirectly."

Recollections of the years of my own life that had no "ups," but all "downs," came before me, and I replied that I was not so sure of the truth of his statement as he appeared to be.

"Have you ever thought of the question before?" he asked, to which I answered that I had not. "Then," he continued, "you have given the matter no mature deliberation, and your opinion is a superficial one. The doctrine, 'Nothing succeeds like success,' is preached daily, but what of the equal verity, 'Nothing fails like failure.' No sermon on that text has ever been read, yet every man will be bettered if he obeys the precepts of a thoughtful consideration of the question: 'Why does success so often fail, and why does failure so often succeed?' Just think it over a moment."

He arose and left the smoker, and I started to "think it over,"—but the moment bids fair to be my lifetime. When he returned, bringing fresh cigars, and after we had settled down to enjoy them, he asked rather abruptly—(this man was full of positive yet kindly abruptness):

"What is your line of business?"

"Electrician," I replied.

"Been successful in it?"

'Yes, reasonably so; at least I have no cause for complaint," I answered.

"Good," he exclaimed. "I can talk with you from your own standpoint. I am not an electrician myself, but I have studied the science some, and I am interested in an electric company of which a relative is manager. Through him I have learned that the electrical business is an extraordinary one in several regards. While the science of electricity is one of the most profound, requiring the highest quality of thought for its comprehension, yet it quickly fascinates the school boy who dabbles a bit, is extolled by admiring parents as a prodigy of electrical knowledge, becomes full of the belief that he knows it all, and starts in business by hanging out his little sign:—

'Electrical Engineer.'

"If he only knew the truth and was frank enough to publicly acknowledge it, he would append thereto the words: 'And Sciologist'.

"The electrical profession has a far greater proportion of smatterers in its ranks than any other. Why? Simply because it is the youngest of the great professions, it is one of the most profound sciences, and its elementary principles are unfathomed by the layman; yet this layman, however shrewd and successful a business man he may be, becomes the first to heed the smatterer's prate and reverence it is unwonted wisdom. How many business men—laymen of course—are there who know how electricity is generated in a dynamo, or who, if they consider the matter at all, would think otherwise than that electricity comes from the armature because of friction that must occur somewhere or other in the machine. Then some tyro comes along, and accidentally explains to his layman—this man of business successes and wealth—that electricity is generated in a dynamo, not by friction, but by the cutting of magnetic lines of force by the wire of the armature, and the tyro at once becomes an electrical expert, in the estimation of the layman. Ordinary business men utterly fail to realize that the words tyro and adept are not synonymous. In fact, there is some warrant for maintaining that business men as a class believe that either one or both of two things exists in reference to electricity; first, that one who knows anything about it knows all about it; and second, that it is virtually impossible to be seriously swindled in many classes of electrical work. No one will demur to the first statement; if the second is incorrect, why is it that business men in making contracts for electric installations will almost invariably set aside their usual conservatism, and agree to buy something, the quality, quantity and value of which they are incapable of estimating? The business man puts his money into a chimerical primary battery project, because the inventor says the scheme will yield such tremendous wealth that it would be fatal to entrust the secret to others, who might steal the idea. The investor accepts the reasoning, and the inventor accepts the cash; the investor finds primary batteries

to be delusive, and the inventor seeks pastures and investors new. Each have profited,—the one in experience, the other basely. A building is erected, and the owner, through his architect, pays for a certain quantity of wire to be placed therein. The contractor does the work, the lights burn satisfactorily, (so far as the owner or architect can judge,) and the work is accepted; yet perhaps the contractor has placed only one-half the quantity of the wire specified. Here, then, the owner contracts to buy something of which he can estimate neither the quality, quantity or value, and he pays well for something he does not get. The merchant who buys goods in that manner will become insolvent. In fact, I can at present recall but one business in which such a commercial transaction as that is not only possible but is actually prevalent, and that is in the electrical business. Now you are an electrician. Do you not know that to be a fact?"

"Yes, that is so," I replied.

The lecturer (he seemed to me to be nothing less) appeared to be thoroughly warmed up to the subject, and at once continued:

"These points, though somewhat irrelevant, have been discussed thus fully, to bring out the fact that the abtruse or hidden relations existing between the electrical industry and other branches of business are unwholesome in this regard, because of the ease with which imposition may be practiced upon the untechnical mind. I have always regarded it as a comparatively simple matter for an electrician, whatever be his skill or ability, to flourish for a time, provided he has a reasonable stock of loquacity and want of principle in his character. This feature has proven the pitfall that has ensnared many and will ensnare more. An easy road to success is yearned for as earnestly as physical comfort is desired, and too many fail to appreciate the distinction between momentary success dishonorably attained, and permanent or true success. The last named may be accomplished only by long and untiring application. Momentary success is like the road to perdition—easy to find,—but it is ofttimes the forerunner of permanent failure. It is then that success fails to succeed and failure succeeds in failing."

He stopped to relight his cigar, while I began to realize that I did not exactly relish the tone of his observations, which appeared to me as serious and perhaps unwarranted reflections upon my own profession. And yet I could not then determine upon just those points wherein I differed from him. I said that he surely did not mean that his remarks were confined to the electrical business, and that I was constrained to criticise his making my own industry appear as a field wherein dishonorable practices might flourish.

"But, sir, they do not flourish in your profession, at best, the success they achieve is but temporary."

"How, then," I interrupted, "is it about the real successes?"

"The first stepping-stone to true success is honorable dealing. He who is in adversity can ill afford to make an enemy, much less to lose a friend; and honor cements good will with all. Honor is a priceless attribute, that when lost is irrevocable. Like patience, it is sometimes bitter, but the fruit is sweet. The man who strives to be successful can not know dishonor; he must be fair to all, and win the esteem of every man. Some men are incapable of making friends, or, having had friends thrust upon them, find it impossible to retain them. No one is so insignificant that his good will can be scorned, for in the good will of his fellow workers will the asipring electrician find the second stepping-stone of the stairs of prosperity. Honor and the ability to cultivate good will or to make friends are God's own gifts to every human being, and pitiable indeed is the one who has had both these attributes blunted in his rearing. With these steps surmounted, the necessity for thoroughness then becomes apparent. A line well learned is better than a volume garbled. Let the information you have be of excellent quality rather than of promiscous quantity, and if you know but little, satisfy yourself that you know that little well. If you reap a particular experience that is of general interest to those in the business, discuss it freely and without reservation. If you are inclined to be selfish, and feel that your experience is your property, and that therefore you will keep it yourself, you may be assured that you do not know much if you fear you will tell it all. If you know anything let the world know it, and the world will then know you. Superficial knowledge like thin ice will support no man, and the fool who ventures thereon and breaks through will find that he can not long be buoyed up by false pretenses. He who assumes to be that which he is not is guilty of hypocrisy, which, when discovered is abhorred.

"You have by this time realized that in my opinion the two great attributes of success in the electrical business are honor and thoroughness, the last of which is but another name for capability. Diplomacy, too, must not be overlooked. It is very essential to success, and to accomplish it, it is well to bear in mind the old precept: 'Pardon another often, thyself never.' Often failure is itself a success, because of the wholesome experince it teaches; and as night brings out the stars, so an electrician's worth is gauged by his ability to surmount oft-repeated failure."

Here, the train entered the Black Canyon of the Gunnison; but as we rode out in the observation car, even amid the wild and almost weird grandeur of that rugged scenery, there yet remained uppermost in my mind the opinions I had heard, and which I have here recorded. If, my fellow electrician, you find that with you "Failure succeeds and success fails," perchance the conversation which occurred in the smoker of that little narrow-gauge Pullman may tell you why.

"WORTHY OF SERIOUS REFLECTION."

"The Telephone," of Chicago, prints in full the editorial on "The Berliner Consolation" appearing in these columns in the issue for June last, observing:

"The Journal of Electricity is the most prominent electrical newspaper west of Chicago, and its comments are worthy of serious reflection."

"A HOWLING SUCCESS."

"The description of our plant in the Bakersfield Edition of the Journal of Electricity is a 'howling success,'" writes Mr. C. N. Beal, secretary and treasurer of the Power Development Company, "and we are very much pleased therewith. So far as the writer's knowledge goes, none of the transmission plants in America, with the possible exception of Cassier's article on Niagara, have been so fully and clearly described. The article seems to do the plant full justice in every way and to reflect great credit upon the Journal and its genial editor."

Illumination

MUNICIPAL OWNERSHIP IN SANTA CLARA.

By Edward A. Quinn.

From an engineering standpoint the municipal plant known as the Santa Clara, Cal., Water & Light Works is not out of the ordinary, but from the standpoint of economy in municipal affairs, some of the larger cities could doubtless take a lesson from "sleepy Santa Clara." Unlike most municipal undertakings, this plant is run in the interest of the town, and not in the interest of politics. Politics did not enter in the affairs of the plant for it was undertaken, built and is operated as a business proposition; and so far it has fulfilled all expectations.

Previous to the erection of the water-works, Santa Clara was supplied with water and light from San Jose, but this service proved very unsatisfactory, and for a long time the advisability of erecting a water plant was discussed. Finally it was decided to issue bonds to the amount of $60,000.00, and to apply this money to the erection of a water and light plant. The water plant was completed at a cost of $56,000.00, and the arc light system at a cost of $9,500.00.

The water flows to a cistern from artisian wells, 250 and 400 ft. deep and from there it is pumped by two 12 x18½ by 12x10 duplex pumps to tanks having a capacity of 180,000 gals. These tanks are situated on an iron tower 80 feet high, which gives a pressure of 40 lbs. in the mains, which are 17 miles in length. The pipe connections to the tanks are so arranged that in case of fire, the tanks are shut off, the water pumped directly into the mains at a pressure of 80 lbs. In summer the daily consumption of water averages 600,000 gallons; in winter a little over one third of this amount.

The steam plant is duplicate, consisting of two 60 horse power tubular boilers, two duplex feed pumps, and a complete duplex system of steam piping. The engine is 60 horse power Corliss engine, and the dynamo a 50 lamp 2000 candle power, arc machine.

Now a word as to the advantage the plant has brought Santa Clara. Formerly, the town paid 15 cents per 1000 gallons for water used for public purposes, which amounted, during the summer months, to about 3000 gals. per month. When a fire took place, the firemen were always handicapped by a lack of water, the pressure on the mains being too low to be of any account. Now that the city plant is in operation about twice the amount of street sprinkling is done: the pressure on the mains is double and when a fire breaks out, the pumps are running almost before the fire bells cease ringing.

Where formerly the town was lighted by 22 arc lights, burning on moonlight schedule, and extinguished at 1 a. m., at a monthly cost of $222.00, there are now in use 43 arc lights and several more are to be added.

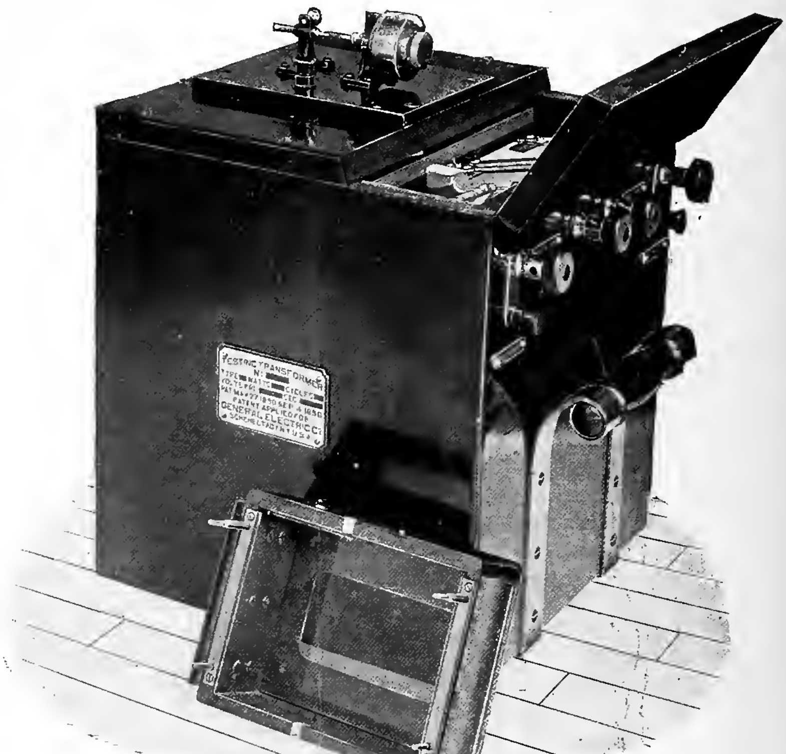
The revenue derived from the water consumers amounts to $700.00 a month. The expenses for operating the plant, for the month of June, for instance, aggregated $370.00; this for the month of heaviest duty when the pumps are run 18 hours a day; and as during the winter months the pumps are operated but six hours, the expense for fuel is considerably less. During December 1896, there was consumed 35 cords of redwood slabs at a cost of $2.15 per cord, or $75.25 for the month; and during last June there were used 74 cords, costing $159.10 for fuel for one of the hardest months in the year, making, an average cost for fuel of say $120.00 per month. Thus the operating expenses average very close to $300.00 per month, leaving a monthly balance of $400.00 to be applied to interest, cancelling bonds, and the depreciation of the plant in general.

The plant is therefore more than self-supporting; and the money which was formerly paid from the tax-collections and went to San Jose, may now be applied to town improvements.

The bonds are 5 per cent, payable semi-annually; three bonds of $500.00 each, to be cancelled every year; and as the years pass and the interest deereases, year, thus reducing the interest by $75.00 per year; and as the years pass and the interest decreases, the net profits of the plant increase, and will thereby allow for depreciation.

HIGH POTENTIAL TESTING TRANSFORMER.

It is a well known fact that electrical apparatus may show high insulation resistance when tested in the usual manner at low voltage and yet may be easily damaged by the application of a few thousand volts potential. A thin film of air will show almost infinite resistance when measured with a galvanic meter, but



A Ten-Thousand Volt Testing Transformer.

it offers practically no resistance to the path of a high tension current. For this reason when determining the security of apparatus, such as the secondary of a lighting transformer, against high potential charges from the primary circuit, it becomes necessary to test by the direct application of high potential across the insulation to be measured. For this purpose the General Electric Company has developed the 10,000 volt High Potential Testing Transformer, which consists of a small transformer wound on a rectangular core similar in construction to that of the "Type H." The low tension circuit is wound on one branch of the core

and on the other branch the primary coils are placed. There are four primary coils, each wound and insulated independently, the four coils being assembled on a sleeve of heavy insulating material. After assembling, each transformer is tested to a maximum strain of 35,000 volts between the high and low potential windings, thus insuring safety from accident. By means of a porcelain series multiple connection board the apparatus can be used on either 52 or 104 volt circuits. The transformer itself is immersed in oil.

On the top of the apparatus is a box with a glass window, enclosing a micrometer spark gap arranged as a shunt across the high potential terminals. This box or cover carries four long contact studs fitting into sockets in the transformer box. The lifting of this cover for the purpose of adjusting the spark gap entirely disconnects the spark gap from the high potential circuits. On one side of the transformer case are six terminals, two for the main circuit, two for the adjusting rheostat, in series with the low potential circuit, and two small terminals providing connections for a volt-moter permanently across the low potential circuit of the transformer. The transformer case is mahogany, the trimmings of nickled brass and polished hard rubber. The case is provided with two handles for transportation, also with a stop cock for drawing off the oil when necessary. Provision is made for readily polishing and re-adjusting the points of the spark gap.

When using the apparatus the spark gap is first set to discharge at the limit of voltage desired, readily done either by the use of a calibration curve, or by a volt meter on the low potential circuit, the ratio of transformation being known. Having adjusted the spark gap, the apparatus under test is connected to the high potential terminals onthe spark gap base and the potential again brought up to the amount desired and held as long as necessary. The apparatus under test is thus connected in multiple with the spark gap, and the accidental application of higher voltage than was intended will surely result in the formation of an arc cross the spark gap short circuiting the apparatus under test and protecting it from damage. The transformer is designed to run on either 80 or 185 cycle circuits and to deliver up to 10,000 volts at a normal current of .05 ampere in the high potential circuit. This, can, howevr, be exceeded for shorter periods.

The rheostat used to control the voltage on the low potential side may be of any convenient type. A small rheostat of portable form for this purpose has also been developed by the General Elctric Company. This consists of a vertical tube and stand with a fixed contact plate at the bottom and another plate attached to a sliding rod, the rheostat being filled with water to which a small quantity of salt or soda has been added.

In the opinion of the engineer of one of the most important electric companies in New York State "the Testing Transformer" has already proved of great value in testing samples of cable and in testing arc switches for use on our new iron poles. There are so many practical tests in which it can be used that it is difficult to say in which direction it is most useful, as with a sufficiently sensitive meter it could be used to determine the static capacity of a short length of cable at the exact periodicity used in practice. But the breakdown tests of insulation in all kinds of apparatus are evidently the most common problems to be met in practical work, and for that alone it is most valuable."

Electro-Economics

THE USE AND ABUSE OF TRANSFORMERS—III.

(Continued from page 104.)

It would hardly do to venture to supply houses wired for 40 lights with transformers for less than 30 lights, and this is about the size which would ordinarily be installed. This means that for the 4,000 total lights there would have to be employed 3,000 lights capacity in transformers. Suppose, however, we divide these 100 houses into five groups, each containing 20 houses. It is simply out of the question that all the lights in all the houses should be burning simultaneously. The total number of lights burning, which has to be provided for, is therefore, less in the 20 houses taken together than in the 20 houses taken separately, and as a matter of fact while there are 800 lights installed in the 20 houses, a 400 light transformer would be ample to supply them with the same margin of capacity as regards overloading possessed by the smaller transformers.

Thus for the total load of 4,000 lights installed there would be required but 2,000 lights capacity in large 400 light transformers, as against 3,000 lights capacity in 30 light transformers of relatively higher cost. Now 3,000 lights capacity in 30 light units would cost, as per our curve, something over $3,000, while the 400 light transformers would cost not much over $1,200. In using the latter there would then be a saving in first cost of something like $1,800; higher efficiency at full load of transformers, and at all other loads, therefore lessened cost of operation, and finally for the same loss in copper, decidedly better regulation, since not only do the transformers improve in regulation as the size increases, as shown heretofore, but the variations in load encountered in working 20 houses from a single transformer, are much less than those made in working the same 20 houses individually.

We will lay down as the first law of the economical use of transformers—That the number of units should be reduced as far as the distribution of service permits.

It will pay to carry this reduction much further than the usual practice. Most alternating plants have been, and many of them still are, great sinners in the use of unnecessarily small units. The law just laid down is evidently not for the immediate interest of the transformer manufacturer, who naturally would like to sell as many transformers as possible, but its tendency is to further good alternating practice, to extend the use of transformers far beyond anything we at present know, and to, therefore, increase the total amount of transformer distribution, so that here as elsewhere "Honesty is the best policy." If it tends to the improvement of practice, to the establishment of new plants, and to the conversion of unprofitable plants into paying ones, it eventually is a direct advantage not only to the user of transformers, but to the maker.

Granting the use of comparatively large transformers for alternating distribution, one must still recognize the fact that occasionally small transformers will have to be used in isolated spots, and during the process of extension. It is, however, undesirable to install a large number of small transformers which will soon be put out of use, except in so far as they can be transferred to other spheres of usefulness. The larger the transformers which can be put to this purpose, the better the general service of the plant. In this connection it is worth while noting that the use of Type H transformers enables the Station Manager to employ for this special service, without loss of efficiency, larger transformers than have heretofore been economically available for the work. This means that during the process of extension, transformers of such size can be employed as will afterwards be useful additions to the system as part of the general distribution.

For example, averaging the claims for efficiency made by five principal transformer manufacturers (excluding the General

Electric Company), the efficiency at full load of a 1,500 watt transformer comes to 95.2 per cent.—the efficiency of the corresponding Type H transformer being 95.9 per cent.

If, however, transformers are to be used for the purposes mentioned, one can obtain from a 6,000 watt Type H transformer, at one-quarter load, an efficiency of 95.4 per cent. In other words, a given load of lamps can be served more efficiently from a 6,000 watt Type H transformer at one-quarter load than from the ordinary good commercial transformers of 1,500 watts capacity, worked at full load. A 3,000 watt Type H transformer at half load has an efficiency of 96.5 per cent, which is relatively even better, so that for extensive and special service it is no longer necessary to use very small transformers, as equally good results can be obtained from Type H transformers of a size which can afterwards be useful, worked temporarily at partial load.

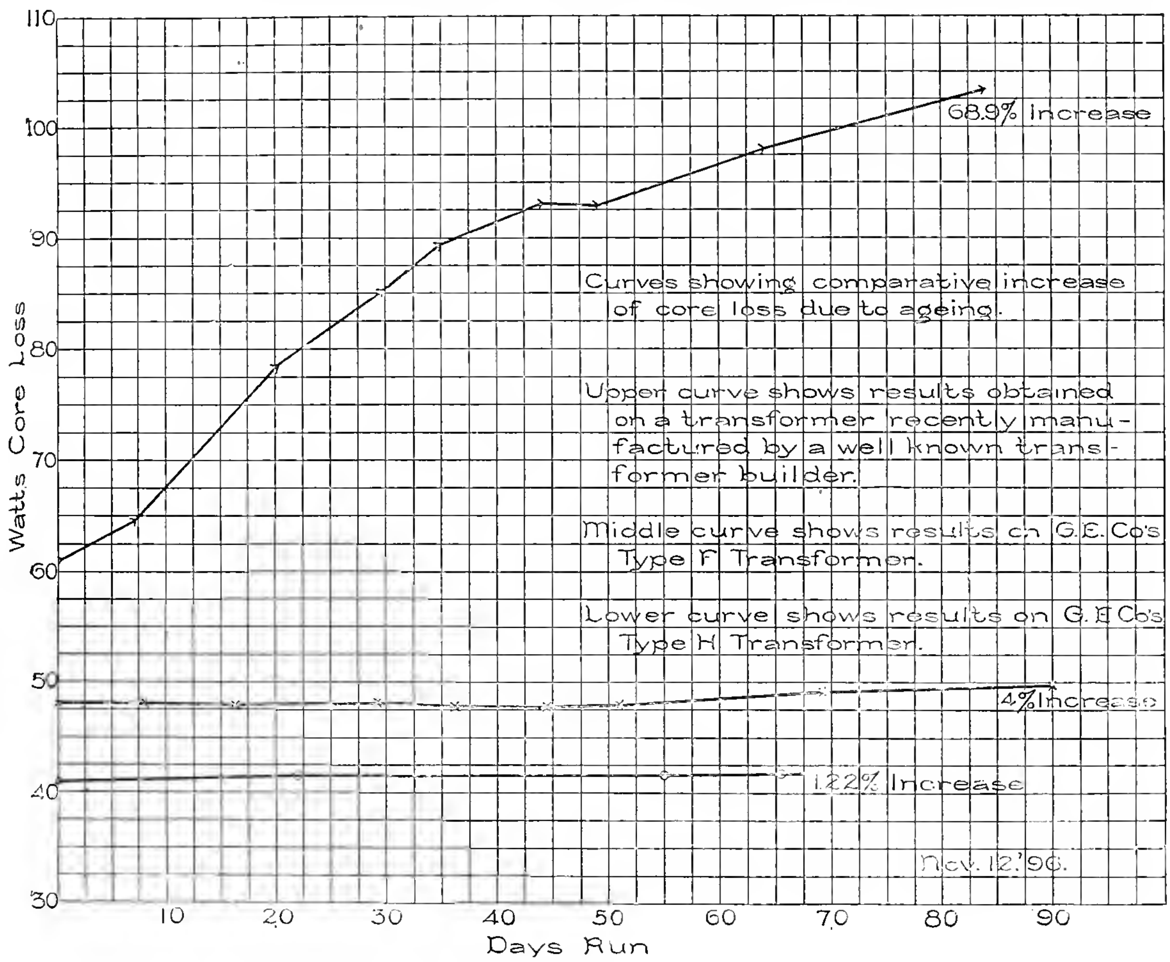
We may, therefore, set down as a corollary to the law of distribution just set forth—That where transformers of moderate size must be used, it is economically desirable to employ such sizes as can be advantageously employed on the general system after their temporary use has been fulfilled.

If alternating distribution is accomplished by the use of large transformers, and therefore comparatively long secondaries, we must recognize the great commercial value of employing fairly high secondary voltages. In the early progress of the art, 50 and 52 volts were the pressures commonly used at the lamps on alternating systems. There was at the time a reason for this in that the regulation of many of the early alternating plants was so bad that high voltage lamps of decent efficiency rapidly broke down.

Fifty volts for modern distribution is absurd, as it enforces either a very large expenditure for secondary wiring or the use of small transformers. More recently, circuits of 100 and 104 volts have been freely used. This, of course, is better, as the amount of copper necessary for the secondaries is reduced to one-fourth under equal conditions of loss, but even these pressures are much lower than are habitually used for direct current distribution, and an adherence to them at the present time simply means additional cost for copper whenever a proper distribution is to be attempted, without any compensating advantages.

At the present time, incandescent lamps can be obtained for 115 volts in every respect equal to those made for 100 to 104 volts. Indeed the vast majority of large Central Stations, operated by continuous currents, employ lamps of these fairly high voltages. A secondary distribution at 115 volts takes 25 per cent less copper than a similar distribution worked out for 100 volts, and the latter has no compensating advantages whatsoever. To employ the lower voltage means simply to throw away 25 per cent of the cost of copper for secondary distribution.

The tendency in all thoroughly modern plants is to the use of the same voltages for secondary distribution as are customarily employed in continuous current plants. Recognizing this condition, the Type H transformers are regularly built for secondary pressures of 115 volts, as well as for the pressures of 100 to 104 volts, used in the old-fashioned plants. The result of this procedure is a marked saving in copper in the secondary distribution without employing special transformers. The Type H transformer is the only commercial transformer regularly manufactured for these high secondary voltages.



We may, therefore, lay down as a second law in the proper use of transformers—That in employing a secondary system of distribution, the pressure on it should be commensurate with that customarily used on continuous current distribution.

The use of large transformers and long secondaries, however, is useful in ways not yet pointed out, as the regulation in these large transformers is vastly better than is found on the house to house transformers. Furthermore, and this fact is of great importance, the load on these large transformers can be kept

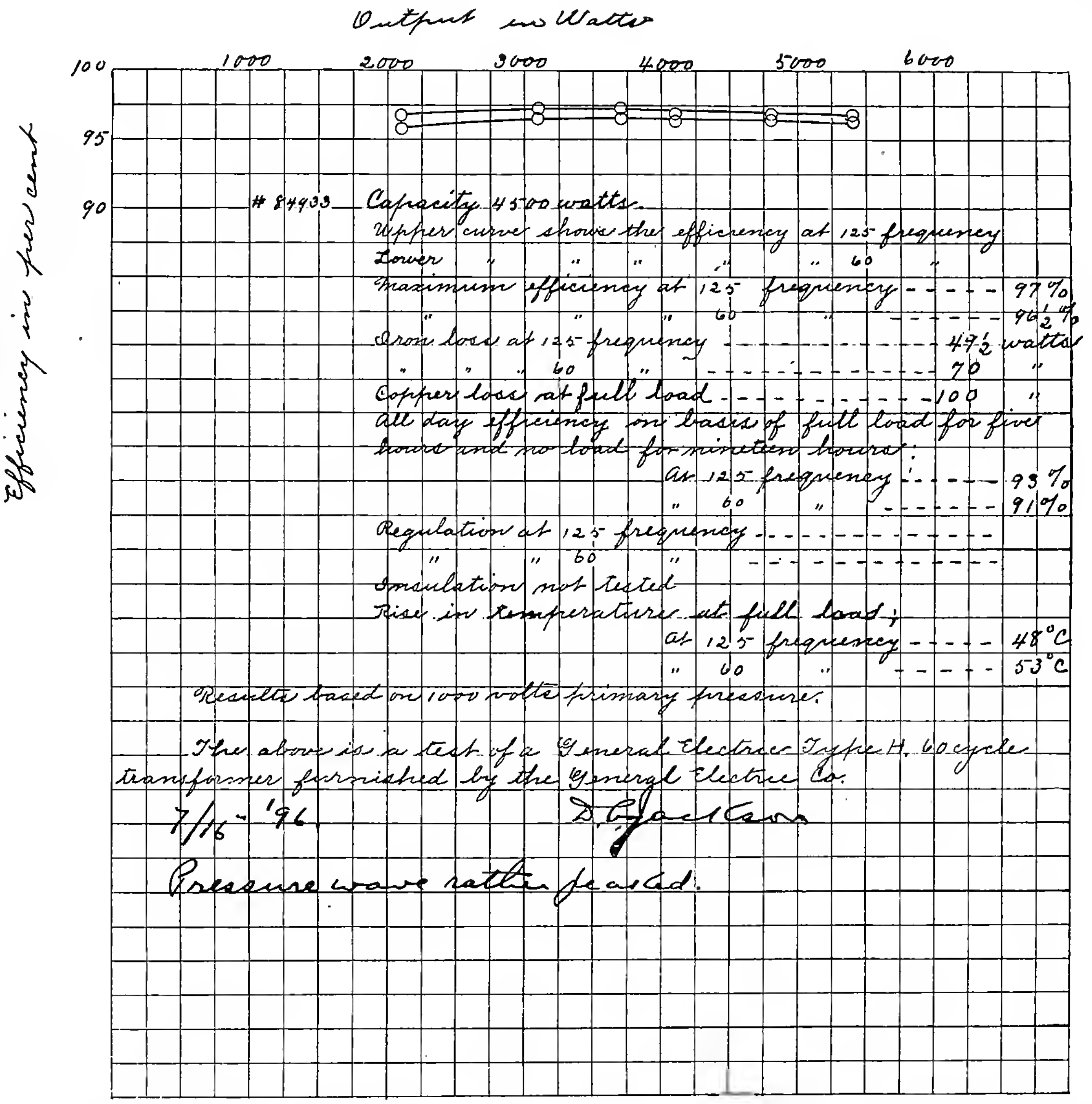
much more uniform than on the small transformers, so that the regulation is relatively better than the actual characteristics of the transformer would indicate, even after we allow them due loss in the long secondaries, and inasmuch as the load from transformer to transformer, and in each individual tranformer, is fairly uniform, when large transformer units are employed it becomes possible to over-compound the generators in such wise as to partially compensate for the losses in the transformers and the secondaries and hold the voltage still more uniform at the lamps.

In many cases this may be done by simply over-compounding the generator, and where the transformer units are comparatively few, special feeder rgulation for the transformers can be employed without difficulty. The station equipment will thereby approximate in its functions, the station equipment of a continuous current station, and by this means the pressure at the lamps may be held closely uniform—as uniform indeed as is the custom in continuous current stations.

When house to house distribution with small transformers is employed, this close regulation of the voltage at the lamps becomes impossible. Witah a large modern station laid out in accordance with the principles herein set forth, it is entirely feasible to run at as uniform a voltage as can be found in any existing plant of any kind, and this in turn renders it possible to employ high efficiency lamps with entire success.

The average lamp used on an alternating system requires much more, nearly four watts per candle, than three, whereas, with good regulation obtained by the intelligent use of the best modern transformers, it becomes entirely feasible to use lamps requiring but a trifle over three watts per candle. In other words, it is possible to save something like 20 per cent of the energy which would otherwise be required to produce a given candlepower at the lamps. In all lighting which is done by contract, this means a very material saving in station expenses, and even when lighting is done strictly by meter at a uniform charge per kilowatt hour, which is not, however, generally customary, the improved service given by these high efficiency lamps is such as to render them of commercial importance to the station manager, even if no direct saving were obtained from their use.

The third law which may be laid down for the economical running of alternating stations is—That the secondary system should have as good regulation as can be obtained, in order that the best lamps may be used and that there may be no need of sacrificing quality in the lamp to the exigencies of bad regulation.



All Type H transformers except the smaller sizes, are wound for a three-wire secondary distribution at either 104 or 208 volts, or 115 or 230 volts.

Often where customers are scattered, the only practical way to reach a sufficient number of lamps from one transformer is to use a three-wire secondary circuit, thus making the secondary voltage 200 volts or over. This practice will not only increase the efficiency of a plant, but will often reduce first cost. For example suppose we have a 30 k. w. transformer installed and are supplying several large customers near by and a customer for

25 lights 500 feet away. If we run a three-wire circuit from this transformer to operate these 25 lamps, allowing only 1 per cent drop, it will cost about $8.00 less than to install a separate transformer for the 25 lights; this because 25 light capacity considered as a part of a 30 k.w. transformer costs so much less than the same capacity in a small transformer.

In the business centers of a city of town, it often pays to run a three-wire secondary and work with suitable transformers feeding into it at various points. By using 115 volt lamps on such a three-wire system and placing the individual transformer near the points of heavy load, the units can usually be of large size and few in number.

Part iii

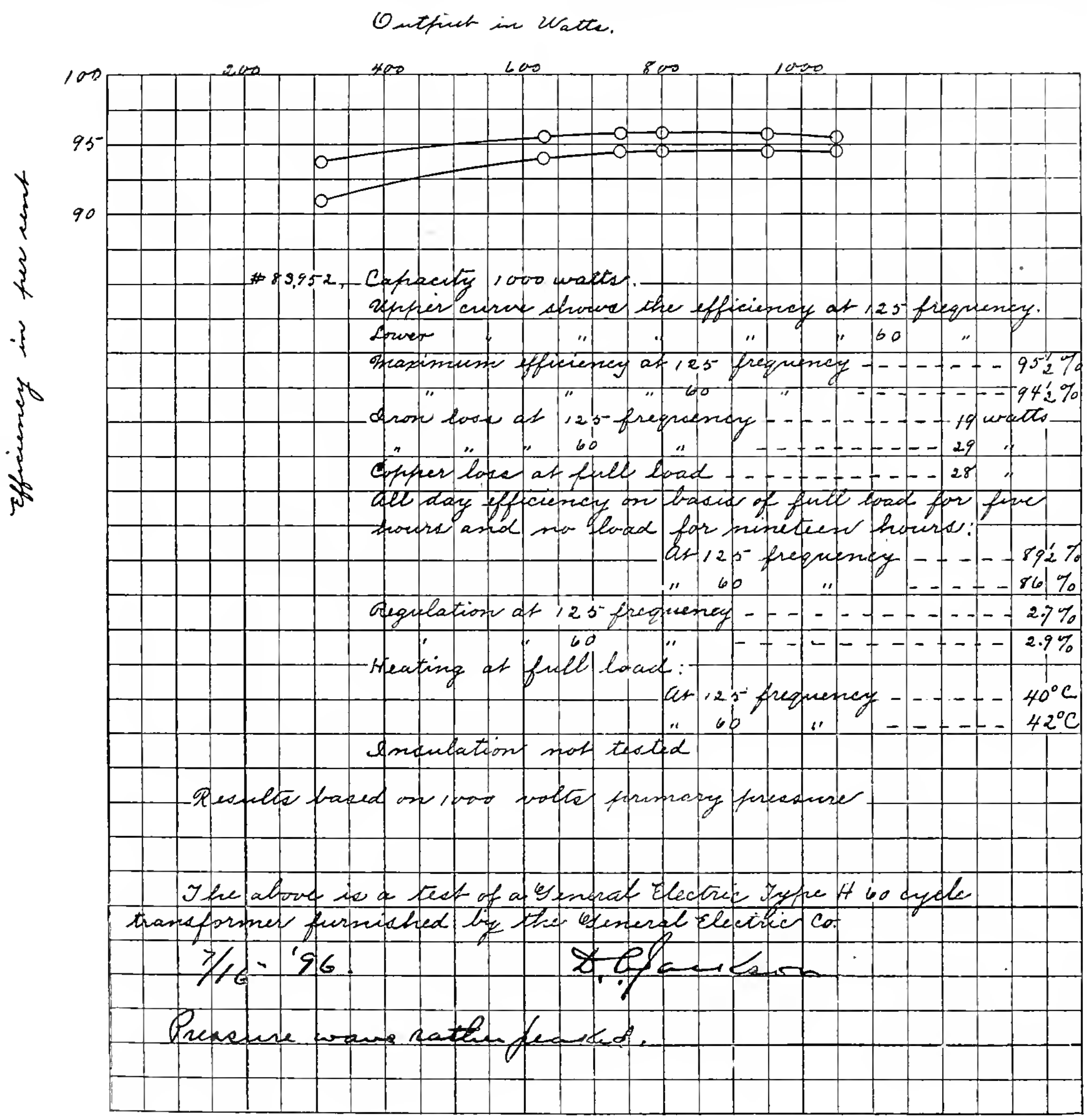
RESULTS OBTAINABLE BY EXCHANGING BAD METHODS FOR GOOD.

To fully appreciate the difference between good and bad transformers, properly and improperly used, we shall have to recur to the question of average load.

Of course, it is understood that a transformer, in a house to house distribution is rarely worked at full load for any considerable proportion of the time. While the transformer may work fairly efficiently for a short time, during the greater part of the day it has absolutely no load or is only slightly loaded. Its all-day efficiency, therefore, is very different from its normal full load efficiency, and this difference is vested in the matter of economy of operation.

It is usual in computing the all-day efficiency of a transformer, to assume that it is fully loaded for five hours and not loaded at all for nineteen hours. This is a condition rather more favorable than that usually met, so that the arguments for economy based on this data are doubly strong.

To show the great difference which low core loss makes in the all-day efficiency of a transformer, and consequently the economy of its use, nothing can be more forcible than to compare the Type H transformers, having extremely low core loss, with the set of transformers tested under the direction of Prof. Jackson and before referred to. The tables in his tests, which have been published elsewhere,* show a complete series of transformer tests, which include tests on various sizes of Type H transformers. Not only is the efficiency of th 1,000 watt Type H transformer greater for all day service than that of any its competitors, even those of more than double its capacity, but its performance both at 125 cycles and 60 cycles bears the same marked superiority.



Now the difference in cost of producing light by the use of first class transformers is most material. For example, we may compare the 1,000 watt Type H transformer with transformer No. 4 of the table, which has 50 per cent greater capacity. Suppose we have 3,000 lights connected and serve them by the use of 100 of the No. 4 transformers of Prof. Jackson's table, the frequency being 125 cycles. The core loss plus the copper loss of these transformers when fully loaded, is 95.7 watts, and the core loss alone is 50.5 watts. This means that the 100 No. 4 transformers when running under no load demand a steady out-

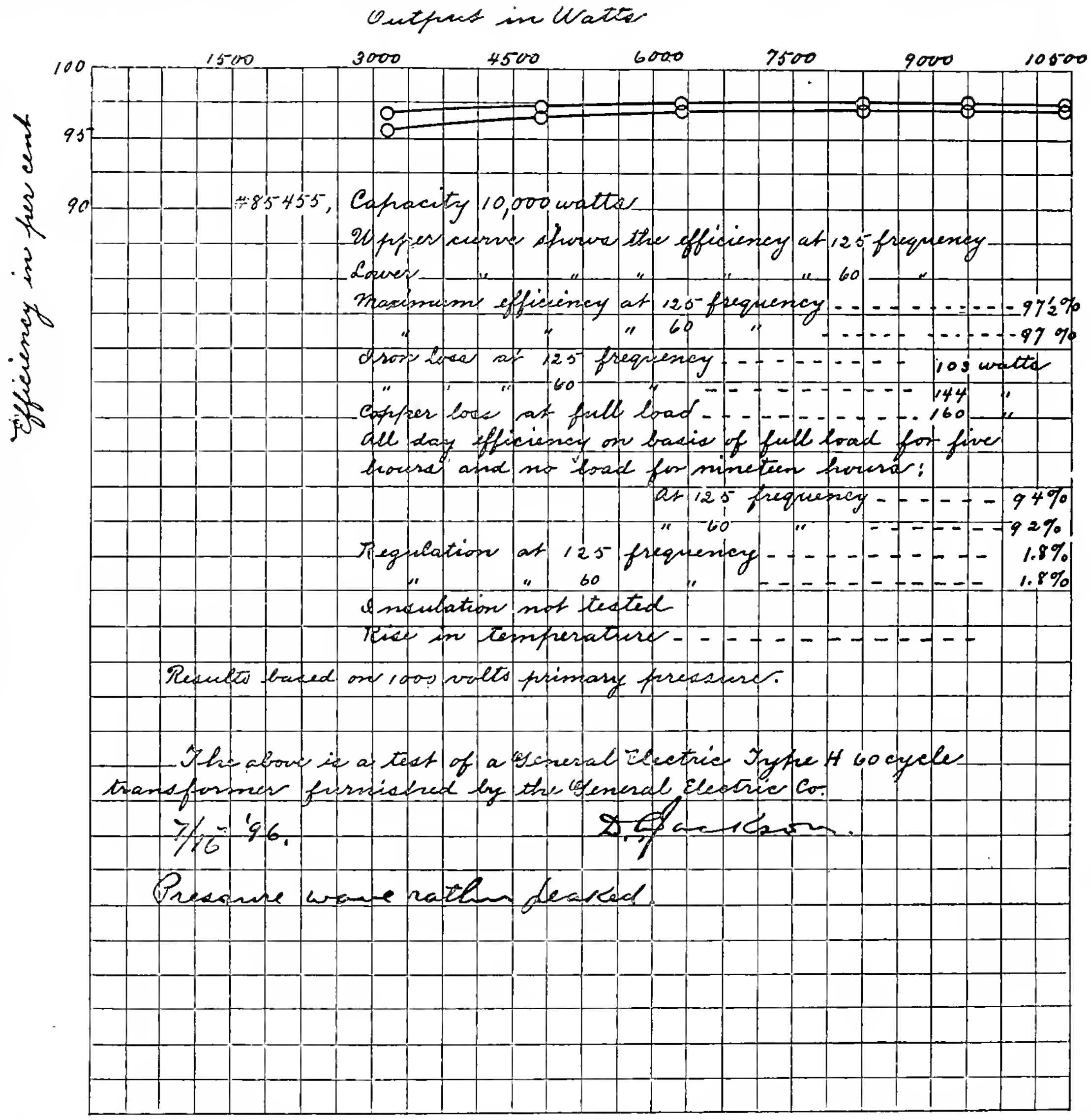
*Bulletin of the University of Wisconsin.

put of about 5 kilowatts. This core loss goes on irrespective of load, and in a station operating 24 hours per day the total yearly loss amounts to 43,800 kilowatt hours. Assuming the cost of putting current into the transformer to be 2 cents per kilowatt hour, which is lower than generally found, there is a steady charge of $876 per year due to transformer core loss alone—$8.76 for each transformer in use.

Suppose now, the same service were accomplished by Type H transformers of 1,500 watts capacity; the core loss of the transformer of this size, 125 cycles, is 27 watts. The total core loss on the 100 transformers necessary would then be 2,700 watts as against 5,000 with the former arrangement. The annual cost of the waste energy on the Type H transformers would be $473, leaving a balance of $403—$4.03 per year in favor of each Type H transformer in service. This saving is clear gain, annually charged against the difference in first cost of the transformers, which leaves still a large margin in favor of buying the best transformer in the first place. A few years of service in fact, at this rate of saving, which is under-estimated rather than over-estimated, would pay for the new transformers, and in a great many cases the very best thing that can be done in the interest of economy is to scrap all uneconomical transformers and put in new and efficient ones.. Aside from the mere saving in energy it is worth noting that the 1,500 watt Type H transformer has a regulation of 2.62 per cent against 3.5 per cent on transformer No. 4, so that not only will it furnish lights more cheaply but will furnish on the average better lights and ensure longer life of the lamps. High cost of fuel or any lack of economy in the operation of a station will increase the difference in favor of the Type H transformer.

In many alternating stations the cost of energy put on the lines is at least double that given, raising the yearly saving in favor of each Type H transformer to $8.06. In a case of this kind it would unquestionably pay to immediately sell the old transformers for what they would bring, or even to scrap them rather than to run them, since new transformers would very rapidly pay for themselves, and thereafter yield a large net income

It should be borne in mind that it is not unusual to find the core loss of transformers increasing after long continued use, which still further exaggerates the difference between transformers having low initial core loss and transformers having high initial core loss. We must not forget, too, that the increased efficiency of the better transformers means increased selling capacity in the station.



The earlier makes of transformers, of which many are still in use do not compare favorably with the best of modern makes. As an example of this we may take the 1,500 watt Type E transformer manufactured by the Thomson-Houston Company, which, in its day, was as good as any other made at the same period. This transformer shows core losses as high as 100 watts. This figure is common in early transformers of all makes. Its meaning is easy to appreciate—100 such transformers shown, as in the previous example, would call for a steady output of 10 kilowatts, costing at the lowest figure, $17.52 for each transformer per year—subtracting from this the $4.73 charged against

the 1,500 watt Type H transformer, there is a saving of $12.79 on each transformer per year to be secured by replacing the old with the new. At 4 cents per kilowatt hour, which is not exceptional, this difference would rise to $25.58 annual saving on each transformer. This would pay for the new transformers in a little over a year, and thereafter net an annual saving of more than three-quarters the total cost of the transformers needed for the plant.

Under these circumstances there is little excuse for keeping old and poor transformers in service any longer than the time it takes to scrap them and get new ones. It must be remembered too, that in purchasing new transformers, we not only lessen the cost of operation but also lessen the cost of maintenance.

From what has already been said of the structural characteristics of the Type H transformers it is clear enough that repairs and depreciation on them will be much lower than anything heretofore found in transformer practice. In addition to this, these transformers run much cooler than is usual with transformers of other types, and consequently from this cause are far less liable to deterioration. In them, as compared with others, the copper and the iron have changed places, so that the copper, in which most of the heat is generated, has the best chance of getting rid of it.

To emphasize the saving due to the use of good transformers, we can do nothing better than to give the actual test of a station in which old transformers were in use, and compare these known results with those which can be obtained by modern transformers, and the use of secondary mains.

The station in question is typical of many which were installed in the early days of alternating lighting, and it is not unusual to find its like even now. It operates 150 transformers, having an aggregate output of 190,000 watts. They are mostly lightly loaded, and made up of three different patterns of transformers in the following sizes:

Ten 300 watt; Fifty-eight 600 watt; Eighteen 900 watt; Twenty-five 1,000 watt; Twelve; 1,500 watt; Seventeen 2,500 watt; Eight 4,500 watt; and Two 7,500 watt.

It should be noted that the average capacity of the transformers is a little over 1,200 watts, and that 123 of the 150 transform-watts output. The observed no load loss in this station was 11,400 watts, of which about 10,000 watts should be charged up to transformer core loss, the rest being divided among various small sources of loss.

This station embodies the three unfavorable conditions of small general load, small transformers, and transformers having relatively high core loss. At 4 cents per kilowatt hour the annual cost of this waste energy would be about $3,500. This amounts to over $23 per transformer installed. The total core loss is nearly 5 per cent of the total output of the transformers, and consequently probably less than 20 per cent of the mean output of the station.

Now let us see what can be done by the use of modern transformers properly installed, toward cutting down this very excessive loss of energy and converting a probable deficit into a surplus. We may retain the house to house distribution and simply change the old and poor transformers for modern and good ones, making only such changes in sizes as are found necessary. To this end, we will replace the 123 transformers of less than 1,500 watts output by new 1,500 watt transformers, combining the smaller ones as advantageously as possible to accommodate the new sizes. The total output of these 123 transformers is 97,000 watts. We should require to replace them about sixty 1,500 watt transformers, of which the total core loss, assuming Type H transformers are used, would be about 1,550 watts. This leaves seventeen 2,500 watt transformers to replace by modern transformers of the same size, the core loss of which will be 610 watts. The larger sizes, eight 4,500 watt and two 7,500 watt we will replace by transformers of the same sizes. The loss due to the 4,500 watt transformers would be 396 watts, that due to the 7,500 watt transformers would be 106 watts, making a total core loss under the improved conditions of 2,712 watts. The change has therefore resulted in an annual saving of $2,550 against which to charge the interest and depreciation of the new transformers.

This is evidently a winning game, and in a very short time the installation with its improved efficiency and lessened depreciation will pay the expense of installing and thereafter turn a handsome balance into the treasury of the operating company.

Of course if the plant is in operation only 12 hours per day instead of 24, the constant losses would be reduced one-half in cost, but even under these conditions, a handsome balance is left to pay for discarding the old apparatus and putting in the new.

By the use of still larger units, and fewer of them, in other words, by lengthening the secondaries, and through the compact part of the district served, using small mains, the waste energy may still further be considerably reduced. For example, the load in question could be readily handled by the use of five transformers of 15,000 watts and eight of 5,000 watts, with fifteen of 2,500 watts to serve the outlying districts.

The aggregate cost of this installation would be very considerably less than if the house to house distribution were maintained, because the aggregate capacity of the transformers with this massing of load, would have to be only a very little over 150,000 watts, or possibly, even less. In addition, the size of the transformers would be increased, thereby lessening the cost per unit of output. The core loss, under these improved conditions, would aggregate only 1,632 watts, raising the annual saving, for 24 hour run, to about $2,900.

Savings like these often mean the conversion of a plant which does not pay, into a good investment, and much of the unsatisfactory financial results which have been only too common among alternating current lighting plants of moderate size, has been due to the reckless use of small and poor transformers.

In plants constituted like the one just described, care in selecting and installing the transformers is especially valuable on account of the relatively high cost of power and the need for installing a larger distributing system than would be necessary for the same service in a larger plant. In new plants the use of poor transformers is simply financial suicide.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

A WORD ABOUT INSULATION.

The pecuniary advantages which will be derived by executing the workmanship called for in electrical contracts so that every requisite to absolute safety, permanance and reliability shall be perfectly satisfied, will not be overlooked by any wide-awake contractor. The art of electric installation is no longer in its infancy. It is well developed and mature and in these days it augurs incompetence in a man to place a piece of work that can possibly become a source of danger. More pointed still is the fact that if the truth were only know, the inexpensive application of a little P & B Electrical Compound at the proper place would forever cure four-fifths of the ills to which electric installation is heir.

To put another statement into the proverbial nutshell that should now be filled with succinct truisms, P & B paint is as essential to permanence and insulation in electric construction as is copper wire to conductivity. Electricians might use iron wire, but they don't. It's cheaper and if there were no copper in the world, iron could be used. But there is copper in the world, plenty of it, and it forms a conductor as far superior to iron as is P & B to the host of imitations of

that worthy commodity. Copper wire bears the relation to P. & B. compound that conductivity does to resistance. One is the reciprocal of the other and consistency alone demands that if electrical contractors find it advisible to use copper in order to attain the highest conductivity, they must also use P. & B. to effect the greatest possible insulation resistance, or they will not have taken the surest safeguard against circuit breakdowns.

This is a day of specialists, the most worthy of which are those pioneers who early recognizing a need, have labored long and assiduously in creating a product to satisfy that need. Paradoxial as it may seem it is oft times incumbent on the pioneer to create a demand for his necessity, and when he finally succeeds, those benefitted by his efforts rub their eyes, wonder at their own short sightedness, and then reward him with handsome patronage. The progress of the age too unfolds new and countless applications for his product, and that which first was but an idea develops into a deftly woven story, intricate in plot and of exceptional virtue.

This recites in metaphor the history and present condition of the Paraffine Paint Company. The electrical fraternity of the Pacific Coast uses thousands of gallons of P. & B., yet little do they know that that staunchest guarantee of permanence in electrical construction was not only invented in California, but can only be made from a product of the Golden State. True to the precepts of the old 49-ers, P. & B. stands ready to meet every condition and to survive every hardship. It is simply invulnerable, whether it guards against the untiring efforts of acids, alkalies or other chemical agents, or the unrelenting action of time and the elements, or the insinuating ravages of electrolysis, or the persistent gnawing of beetles, rats and mice, or the hunger of the aqueous toredo.

In brief, if you meet with any condition that calls for an extraordinarily careful installation, use P. & B. Electrical Compound.

SELF STARTING SINGLE PHASE A. C. MOTORS.

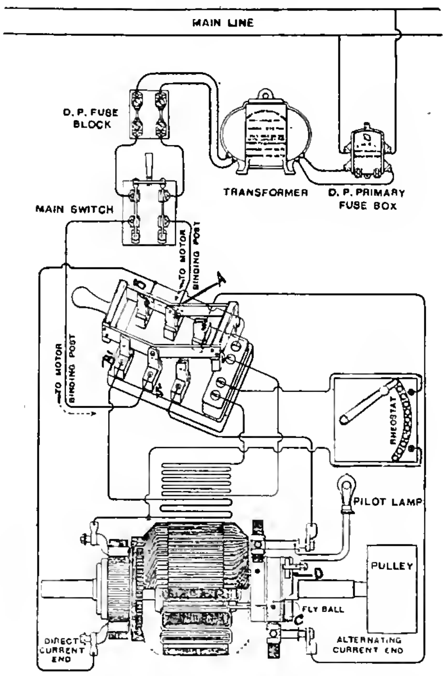
By W. W. Briggs.

To the electrical engineer and designer the production of a commercially successful single phase alternating current motor which would start under full load, has been a problem of great difficulty. A year ago the Fort Wayne Electric Corporation placed on the market a motor which meets these requirements, namely—To operate on the ordinary single phase circuit; to start uder full load; to be efficient; and last, but not least, to be so simple that when placed in the hands of the novice there shall be no difficulty in his being able to get good and continuous service from them.

By referring to the accompanying diagram which shows the connections for the wireman in installing, it will be at once apparent that the wiring for this motor is perfectly simple and the same as wiring for any two wire service. The main leads from the transformer connect directly to the binding post at A and A, without the use of the rheostat or starting devices, as the self induction of the motor is sufficient to choke back any abnormal flow of current.

The armature is wound with two separate windings —one a distributed winding connected to an ordinary direct current commutator; the second is the regular concentrated winding (similar to that of the A. C. generator) and terminates at two collector rings; the third collector ring, shown on the diagram, is the mechanical medium for connecting the lamps across the transformer terminals, by means of the fly ball, a centrifugal device, which by lighting the lamps indicates when the motor is up to speed or synchronism. The fields have also two windings, similar to that of the compound wound direct current generator; one being a coil of few turns, and the other being a regular shunt winding. The entire field structure, as well as armature, is built of thin iron punchings. On the direct current side, carbon brushes are used, guaze brushes being used on the collector rings.

In starting this motor the switch handle is depressed to switch clips B & B. If the reader will follow the connections as shown by the diagram, he will see that the alternating current flows first through the series winding of the field, thence to the commutator and distributed armature winding back to the switch—thus starting the machine as a series motor. As soon as the current is turned on the motor will rotate with constantly accellerating speed until synchronism is at-



Circuit Connections of a Synchronous Motor.

tained, which is indicated by the fly ball (at point C in diagram) being thrown out by centrifugal force and coming in contact with the third collector ring D, connecting the single pilot lamp on the top of the motor to the transformer. When the lamp lights it is a signal to reverse the double throw switch, which changes the connections, so that the transformer leads are cut off from the commutator and connected to the concentrated armature winding through the collector rings, at the same time the leads of commutator side are connected to the shunt winding of the field, thus furnishing direct current to excite the same. In circuit with the field winding is a rheostat (mounted in one of the pedestals of the machine) for the purpose of controling the extent of the field excitation.

When the lamp lights and switch is thrown over, the motor will be running in synchronism with the generator, from which it derives its energy. Where constant speed is desired it is the most satisfactory motor that can be produced; its efficiency is high and its regulation perfect.

The writer has often thrown an overload of 50 per cent on and off the motor without changing its speed in the least. It is remarkable the amount of overload one of these machines will carry without falling out of step. In a recent test with ' strap brake, the writer was enabled to make the watt-meter register a running consumption of 6000 watts on a 1 horse power motor before it broke out of step and stopped.

To the electrician not accustomed to the vagaries of A. C. motors they are very confusing. Some few months ago the writer set up one of these motors and started and adjusted the field excitation to the load it was to carry. The ammeter indicated 10 amperes, and the voltmeter 110 volts; then, while motor was running with full load, without changing anything, the belt was thrown off and the ammeter jumped to 22 amperes at 110 volts, thus seemingly consuming more current running idle than when it was carrying a load. This current was largely made up of a lagging, or so-called "wattless" current, which, while it takes no power to produce, yet uses up capacity in generator transformer and line due to C losses. In this respect these motors have a decided advantage over "Induction" motors, where the power factor (which is the ratio of the real to the apparent energy) varies from 20 to 80 per cent; as the ability to adjust the field excitation does away with the lag current, line inductions, etc. In fact, with the motors from 2½ horse power up, it is possible to put a leading current on the line, doing away with C' R losses.

The motor can be made to run in either direction by rocking the brush yoke through an arc equal to the pitch of the poles, or in other words, from the center of one pole to that of the next, which is the equivalent to reversing the leads or polarity of the direct current end. When in operation this motor runs without sparking.

ELECTRICITY IN A MODERN NEWSPAPER OFFICE.

The new building at the corner Third and Market streets, San Francisco, now under erection for the "Examiner," will make use of Electric Power in all of the various departments. The power plant will be located in the basement and will consist of water tube boilers, 6 high speed engines of a rated capacity of 75 horse power each, and 6 generators of 50 k. w. capacity each, mounted on the same sub-base and directly connected to the main engine shaft. The plant will generate current at 220 volts for the light and power service throughout the building.

Special attention will be given to the switchboard, which will consist of three panels of Italian white marble, one for the lighting service, one for the power service, and the other for the instruments and generators. The switches upon this board will be so arranged that all of the generators may be thrown in multiple or any or all of them may be cut out and current taken from the street service. All of the switchboard instruments will be of the Weston illuminated dial pattern and each circuit leaving the switchboard will be provided with an automatic circuit breaker, entirely dispensing with fuses.

There will be two 5 horse power motors operating a trolley in the basement; two 25 horse power motors operating quadruple presses; one 50 horse power motor operating a sextuple press; three sidewalk elevators; two electric passenger elevators; two 5 horse power motors operating the matrix machinery and several other motors distributed throughout the building for various service. The wiring system will be iron armored conduit throughout, all of the motors and lamps being placed upon the 220 volt circuit, for which reason the consulting engineer has asked for an exceedingly high insulation test. There will be a local telephone system connecting the heads of the different departments, so that the business manager may converse with any of his employees from a telephone on his desk.

Mr. E. R. Knowles of 150 Nassau street, New York, is the consulting engineer for the "Examiner" plant; and the installation will be made by the Wybro & Lawrence Co., under the direct supervision of Mr. H. C. Wybro, who also acts as consulting engineer representing Mr. Knowles. Mr. Wybro has the experience gained from twelve years' practice in constructing, operating and selling electric and steam machinery, and in addition to being a practical mechanic, he has been manager of several electric light and street railway companies, and for the past three years he and his company have handled nearly all of the large contracts that have been awarded in Southern California.

The Wybro & Lawrence Co. has a store room at No. 522 South Broadway, Los Angeles, in charge of Mr. Geo. W. Lawrence, and its San Francisco office, which Mr. Wybro has in charge, is located at No. 53 Chronicle building.

ELIMINATING A "BUG" IN INTERIOR TELEPHONY.

There are a great many interior systems in use in San Francisco, and one of the chief difficulties experienced is that unless a hand is moved back, on a dial, or a button depressed, or a plug moved after the conversation is over, the party who has done the calling is cut off from the calling circuit entirely and it is impossible for any one else to ring him up.

The party doing the calling is supposed to make these changes when he is through talking, but sometimes it is forgotten, rendering the telephone useless and causing an unnecessary waste of battery. By the introduction of an ingenious and simple device brought out by the Brooks-Follis Electric Corporation, in the switching apparatus, this difficulty is overcome and the line is automatically restored to its normal position by the action of replacing the receiver. This attachment leaves the telephone always on the ringing circuit ready to receive calls. These instruments are well made and talk remarkably clear and loud. Mr. J. E. McGillivray designed and perfected this system and is associated with the Brooks-Follis Co. in introducing them.

The Brooks-Follis Corporation has received a large assortment of standard telephones and apparatus in all styles and for all classes of work, and is prepared to quote prices on telephones for long and short distances or on intercommunicating interior systems.

The corporation also constructs and equips complete private lines and exchanges.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

Tuolumne county will soon have in active operation an enterprise of great magnitude, by means of which the people of this section will ere long be possessed of an electrical plant which will cost at least one million dollars, and which will furnish light and power to thousands. Sonora district is to be furnished with a branch line, and if found practicable, the lines will be extended into the valleys around about. The power is to be introduced into factories and operative establishments of all kinds. This, taken in connection with Captain A. H. Ward's currents, which will be developed by the falls in the Yosemite Valley, will give to this and adjoining counties the cheapest energy in the world. Now, with this accumulation of electrical forces, how long will it be until trolley freight and passenger cars will be rolling through these valleys? This is no idle speculation. It is a fixed fact. This is the age of electricity. Old fashioned horse power will soon be a thing of the past. Steam, except for generating energy where water is not available, will follow and electric force and light will rule.—Calavaras, Cal., Prospect.

Bakersfield Edition.

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